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Held in

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March 19, 1971

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BEN LAFLIN — PIONEER

D. H. MITCHELL, Grower, Coachella, California

What does the word **pioneer** suggest? Such thoughts as hardship, courage, adaptability, persistence, judgement, neighborliness and the ability to lay the foundation for future progress? Yes — and our friend Ben Laflin had all of these qualities.

Ben became a farmer in the Thermal area in 1914 when there were few of the comforts of life that we now enjoy. He farmed a variety of crops and was one of the first date growers.

Back in the twenties Ben was deeply involved in the fight to eradicate Parlatoria date scale, which had been introduced when thousands of date offshoots were brought in from the date-growing regions of the Old World. Present-day date growers should be grateful that the pest was wiped out, as such a result could only be accomplished when the industry was small.

As the years went by, Ben became a grower of the Medjool variety as well as Deglet Noor. He and his family maintained a date shop at the home ranch. Recently it was moved into an attractive building on Highway 111 and an extensive distribution through mail order was built up that covered the nation.

One of his early side lines was the manufacturing of various kinds of equipment in the shop on his ranch and sale to other date growers of such articles as date saddles, dethorning knives and other tools.

The rotary ladder was his invention. It consisted of a circular track which could be moved from palm to palm and upon which an extension ladder would move around the palm for harvesting. This piece of equipment outgrew its popularity, however, when the palms became so tall that it was no longer efficient.

Ben was a leader in many fields of service — his church, the Farm Bureau, Thermal Chamber of Commerce, the early Lions Club — and served as a Trustee on the Board of the Coachella Valley High School. In summary, he was typical of the citizen that built America — a real pioneer.

No tribute of this sort is ever complete without mention of his lifelong companion and partner, Lucy. She, too, is an outstanding pioneer. The family tradition is being carried on by their son Ben Junior. Truly a family of which the Valley can be proud.

FUMIGATION OF DRIED FRUIT INSECTS WITH HYDROGEN PHOSPHIDE AND ETHYL FORMATE

L. E. VINCENT and D. L. LINDGREN[1]

INTRODUCTION

Harvested dates may be infested with 4 species of nitidulid beetles, namely the corn-sap beetle, **Carpophilus dimidiatus** (Fab.); the dried-fruit beetle, **C. hemipterus** (L.); the pineapple beetle, **Urophorus humeralis** (Fab.); and the yellowish nitidulid, **Haptoncus luteolus** (Er.). Normally these nitidulid beetles do not continue to breed under packing house conditions as they usually require soil in which to pupate. In addition, the sawtoothed grain beetle, **Oryzaephilus surinamensis** (L.); the Indian meal moth, **Plodia interpunctella** (Hbn.); and the raisin moth, **Cadra figulilella** (Greg.), infest dates, but differ from the nitidulid beetles in that they continue breeding generation after generation in the packing house and in the packaged product, thus becoming a serious problem. The nitidulid beetles are usually associated with dates of high moisture content and spoilage, whereas the other 3 insects can also develop in unspoiled fruit of low moisture content. Under conditions where harvesting is delayed until the entire bunch is removed, the dried dates are extremely vulnerable to attack in the field by the 2 moth species and the sawtoothed grain beetle.

To prevent entry of these insects into the packing house, fumigation of all incoming fruit is essential. Methyl bromide is the fumigant currently licensed for use on processed dates, having a residue tolerance of 125 parts per million (ppm) Br (1). In seeking more effective fumigants, we conducted laboratory experiments to determine the effectiveness of hydrogen phosphide and ethyl formate against this group of insects.

Hydrogen phosphide has been used as a fumigant in the United States for the control of stored grain insects since its introduction approximately 15 years ago (3, 4, 11). The proprietary compound (Phostoxin®)[2] is manufactured as a highly compressed tablet or pellet composed of ammonium carbamate and aluminum phosphide, which on exposure to moisture decomposes to hydrogen phosphide (H_3P), aluminum hydroxide, ammonia, and carbon dioxide. This decomposition is slow and dependent on the relative humidity and temperature of the air. Each tablet weighs 3 grams and, upon decomposition, produces 1 gram of hydrogen phosphide. Each pellet weighs 0.6 gram and releases 0.2 gram of gaseous hydrogen phosphide. Residues of phosphine in or on processed foods cannot exceed 0.01 ppm and on raw products 0.1 ppm (1).

Ethyl formate is a colorless liquid having a boiling point of 54.5° C; thus it is a fumigant that can be handled as a liquid at ordinary temperatures. Ethyl formate was tested by Neifert **et al.** (6), Cotton and Roark (2), Roark and Cotton (7), Simmons et al. (9), Shepard **et al.** (8), and Simmons and Fisher (10). Mayer and Nelson (5) found that ethyl formate was not effective for fumigating beans and peas in cellophane bags under practical operating conditions. Ethyl formate is licensed for use in or on raisins and dried Zante currants as a bulk and package fumigant, provided that the total formic acid present, free and combined, in the finished product shall not exceed 250 ppm (1).

MATERIALS AND METHODS

Stock cultures of the 4 species of nitidulid beetles were maintained in gallon jars on untreated dates at 80° F and 70% relative humidity (R.H.) Approximately 2 inches of moist sand was placed in each jar to provide pupation sites. Dates were placed on the surface of the sand and adults of the respective species introduced.

Eggs of the nitidulid beetles were obtained by exposing to adults 2 pieces of plastic 1 x 3 inches with a piece of moist blotting paper in between. A crevice between the blotting paper and plastic was obtained by placing a small piece of filing card ¼ x 1 inch between the blotting paper and plastic, the entire unit being held together with a rubber band. This crevice allowed the insect to insert its ovipositor between the blotting paper and plastic and deposit its eggs (Fig. 1). Nitidulid larvae, pupae, and adults of known age were obtained by starting a culture from known-age eggs. These were reared on a paste consisting of ground dates and active yeast which was allowed to ferment for several days prior to use.

A similar procedure was used to obtain the various life stages of the sawtoothed grain beetle, except the rearing medium consisted of rolled oats, raisins, and walnut meats.

The 2 moth species were reared on a medium consisting of bran, honey, glycerin, yeast, and wheat germ. Eggs were obtained by confining approximately 100 adults within a pint jar containing a small amount of food medium, with a 20-mesh screen cover, the whole being inverted over a petri dish. Any eggs laid by the moths dropped through the screen into the petri dish and were collected at daily intervals.

All fumigations were conducted in one-liter glass flasks at a temperature of 80° F. The dosage of H_3P applied to these flasks was measured as a gas with a glass syringe from a supply obtained by the decomposition of a Phostoxin tablet in a 20-liter glass bottle. The concentration of H_3P in the 20-liter supply bottle was determined by gas chromatography and the dosages desired for the one-liter flasks were calculated from this concentration. By this method the test insects were exposed to a constant concentration of H_3P for the duration of the exposure period. The concentration of H_3P as determined by gas chromatography showed little or no sorption by the glass fumigation chamber.

Ethyl formate was measured as a liquid with a microsyringe and injected onto a small piece of filter paper within the fumigation flask to facilitate evaporation.

To prevent desiccation of the test insects during the exposure period, we placed a small piece of moist blotting paper in each fumigation chamber prior to introduction of the fumigant. Following fumigation the test insects were held at 80° F and 70% R.H. Mortality counts of adults and larvae were made 7 days following fumigation; eggs were observed until no further hatching occurred, and the pupal counts were based on the number of adults emerging.

In all experiments 50 or more eggs of each species were used for each test. Twenty-five or more larvae, pupae, or adults were used in each test, except that in tests involving the 2 moths 10 adults were used. Five or more points were obtained to establish a dosage-mortality curve and each point on the curve represented the average of at least 5 replications. The LC_{95}[3] values were estimated from eye-fitted lines.

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[2] Phostoxin®; manufactured by Degesch-Deutsche Gesellschaft für Schädlingsbekampfung, Germany. American supplier: Hollywood Termite Control Co.

[3] Concentration lethal to 95% of the test insects.

Table 1. Results of fumigation tests with hydrogen phosphide on various stages of several stored product insects. Exposure: 24 hrs at 80° F.

Insect	LC_{95} (ppm)			
	Egg	Larva	Pupa	Adult
C. hemipterus	23.3	6.0	24.1	2.2
C. dimidiatus	143.1	15.1	21.8	6.2
U. humeralis	23.3	10.5	13.2	2.9
H. luteolus	94.1	5.5	4.7	3.5
O. surinamensis	28.6	12.4	36.9	13.6
C. figulilella	105.4	12.8	65.5	15.8
P. interpunctella	1430.7	45.2	241.0	25.6

Table 2. Results of fumigation tests with ethyl formate on various stages of several stored product insects. Exposure: 6 hrs at 80° F.

Insect	LC_{95} (mg/1)			
	Egg	Larva	Pupa	Adult
C. hemipterus	48.0	34.0	72.0	30.6
O. surinamensis	22.3	33.0	48.5	22.0
C. figulilella	9.0	23.2	29.0	6.3
P. interpunctella	9.0	26.5	36.0	7.3

RESULTS

Hydrogen phosphide. The results indicate that the life stages of the insects tested are all susceptible to fumigation by hydrogen phosphide (Table 1). All stages of the Indian meal moth were more difficult to kill than comparable stages of the other species tested. In general the egg stage of each species was the most difficult to kill followed by the pupa, while the larva and adult were the most suseeptible stages. Measuring toxicity of H_3P in ppm indicates the effectiveness of this fumigant against the insects tested. Dosages of most fumigants are measured in lb./1000 ft.^{3} One oz/1000 ft^3 of hydrogen phosphide is equal to 753 ppm. By comparison the recommended dosage of methyl bromide for date fumigation is 1 lb./1000 ft^3 for 24 hours, which is equal to 4112 ppm.

Ethyl formate. In susceptibility of the insects tested to ethyl formate fumigation (Table 2), the dried-fruit beetle ranked the most resistant followed by the sawtoothed grain beetle, while the Indian meal moth and the raisin moth were the most susceptible. In the insects tested the pupal stage was the most resistant and the adult stage the most susceptible. With the exeeption of the dried-fruit beetle, the egg stage was more susceptible than the larval stage to ethyl formate fumigation. The dosage of 72 mg/l of ethyl formate required to kill 95% of the pupae of the dried-fruit beetle, the most resistant stage in all insects tested, is equivalent to a dosage of 2.2 ml/ft.^{3} The dosage of ethyl formate currently recommended for fumigation of processed packaged raisins is 0.3 ml per pound package and 5 ml per 30 lb. ease (0.6 ft^3) during summer and 7 ml per case in winter (1). A successful fumigation would depend upon a relatively gastight package or earton and the injection of the fumigant just prior to sealing (e.g., heat seal of polyethylene).

SUMMARY

The relative toxicity of hydrogen phosphide (H_3P) and ethyl formate to several speeies of stored-product inseets and their life stages was determined. In general, with hydrogen phosphide, the egg stage of each species was the most difficult to kill followed by the pupal stage, while the larval and adult stages were the most susceptible. The pupal stage was the most resistant to ethyl formate fumigation, whereas the adult stage was the most susceptible. With the exception of the dried-fruit beetle, the egg stage was more suseeptible than the larval stage to ethyl formate fumigation.

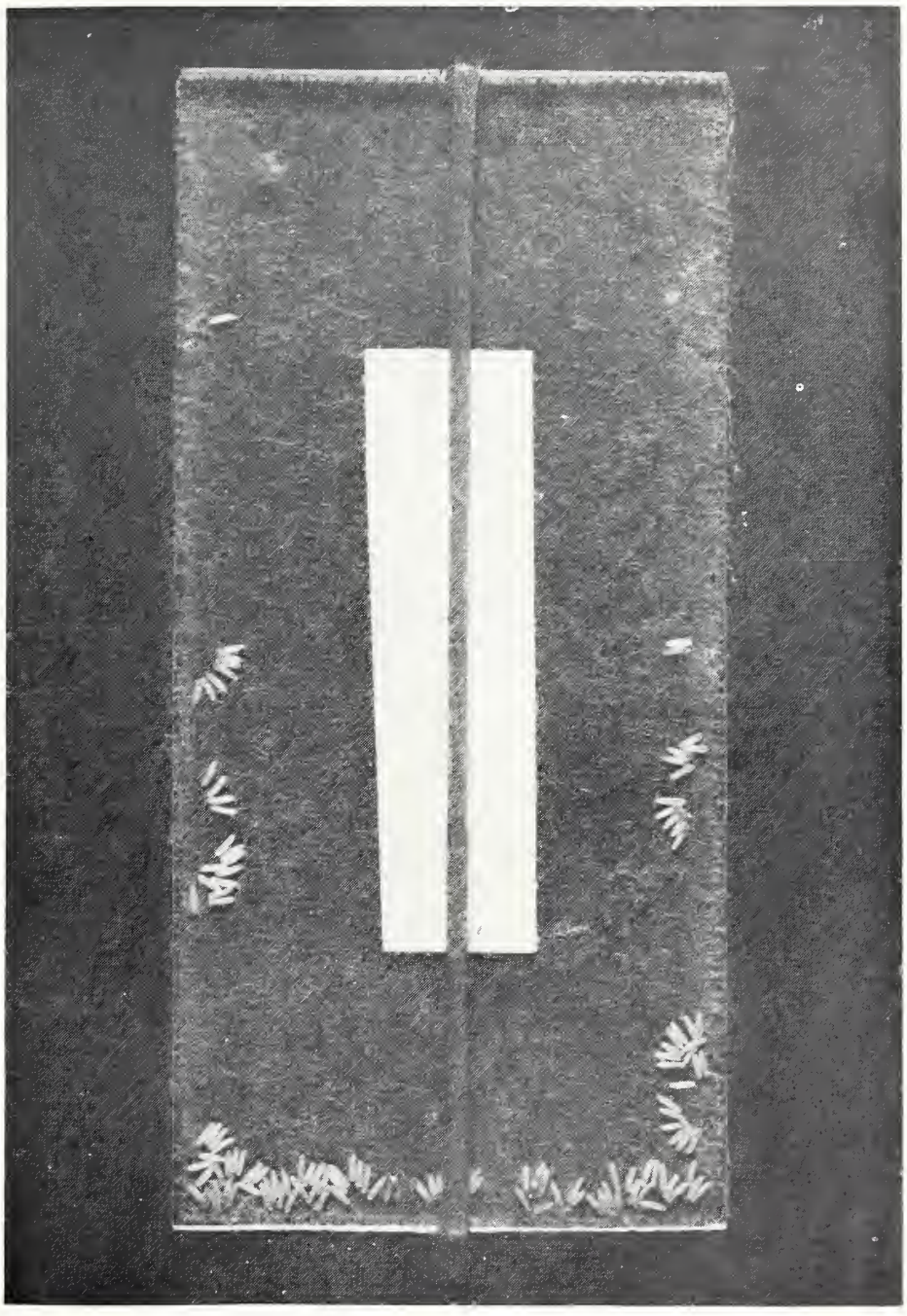

Fig. 1. Eggs laid by Urophorus humeralis in crevice between plastic and blotting paper.

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BIOLOGY OF BATRACHEDRA AMYDRAULA MEYR., THE LESSER DATE MOTH

IBRAHIM FAHMY MICHAEL and ABD-ALLAH HABIB[1]

Batrachedra amydraula Meyr., the lesser date moth (Fig. 1), is one of the major date palm insects in Sinai Province. It was recorded for the first time in the United Arab Republic by Michael and Abo-El-Ghar (6). Studies on the biology and life history of this insect have been done by Buxton, 1918 (2); Dutt, 1922 (3); Rao, 1922 (7); Wiltshire, 1957 (8); Martin, 1958 (5); and Abd El-Hussain et al. 1963 (1).

Fig. 1. Adults of B. amydraula, male (left) and female (right). See reference (6) for a diagrammatic drawing of the insect.

Methods and materials. Larvae of **B. amydraula** were collected and placed in one-half liter glass jars under laboratory conditions and at a constant temperature of 25° C. and 72.5 ± 2.5% relative humidity. The larvae were fed on dates until they pupated. When the adults emerged they were sexed and kept in groups of 5 males and 5 females in one-half liter glass jars covered with cheese cloth secured with rubber bands. A strand containing 8 to 10 immature date fruits was put in each jar as a place for depositing eggs and as food for the larvae. Observations were taken daily.

Egg stage. The eggs are oval and average 776 mu long and 512 mu wide. Eggs are laid on immature date fruits individually or in batches of 2 to 5 (Fig. 2). Newly laid eggs are transparent and assume a yellowish-orange color after one day. An increase in temperature from 25 to an average of 32°C caused a proportional and significant decrease in the incubation period.

Larval stage. At eclosion the larvae are about 1 mm long (Fig. 3) and yellowish, turning to light brown after one day. Just after hatching, the larvae are very active, moving all over the date fruits. Finally they move towards the proximal end of the fruit. A full-grown larva in its fifth and last instar measures about 8 mm long. The differences between the means of the duration of the larval stage at the 2 temperatures tested were significant.

According to Dyar's law, after Imms (4), the larva of **B. amydraula** has 5 instars. The observed widths of their head capsules in mm were as follows: 1st instar, 0.25-0.27; 2nd instar, 0.36-0.43; 3rd instar, 0.48-0.49; 4th instar, 0.58-0.63; 5th instar, 0.68-0.80.

The larva becomes motionless and whitish at the end of the larval stage. This stage can be considered as the prepupal stage, in which the larva starts spinning its silky, light-brown cocoon.

Pupal stage. The pupal stage lasts from 12 to 17 days with a mean of 14.25 at an average temperature of 28-34°C, and from 14 to 20 days with a mean of 16.1 at a constant temperature of 25°C. The difference between the 2 means is significant. Pupation occurs in the palm fibers at the base of the leaves or in the soil. When occurring in soil the larvae use some sand particles to support the walls of their cocoons. Maximum pupal length ranges from 5-6.5 mm., and the width of the pupa ranges from 0.8-2 mm (Fig. 4). The pupa is originally creamy and becomes darker in its advanced stages.

Pre-oviposition period. The pre-oviposition period of the females is about 2 days under either laboratory or controlled conditions. However, more variations occur in the pre-oviposition period at a constant temperature of 25°C than at fluctuating temperatures.

Adult stage. The adult moth (Fig. 1) is pale ochreous brown and males and females average 5 and 6 mm long, respectively. The wing span of males is 13 mm; that of females, 14 mm. The longevity of the adult stage is affected by the prevailing temperature (Table 1). Differences between the means at each temperature range were significant.

Oviposition and number of eggs per female. Oviposition takes place at night. Eggs were deposited on dates and strands and occasionally on the glass walls of the containers. The total number of eggs laid per female ranges from 6 to 25 with a mean of 12.6 ± 2.39 and from 11 to 25 with a mean of 18.1 ± 2.91 under laboratory and controlled conditions, respectively. The differences were not significant.

At 25°C the oviposition period is about 3 days, while at an average temperature of 31-32°C it is one day. Constant temperature of 25°C is more favorable to the ovipositing females than a fluctuating temperature averaging from 31-32°C.

Duration of the life cycle. The duration of all the developmental stages from the egg stage until the death of the adult moth varies greatly according to the prevailing temperature. It averaged 44.4 days under the constant conditions used and 31.9 days under the laboratory conditions.

Generations and overwintering. Observations carried out for 3 years showed that

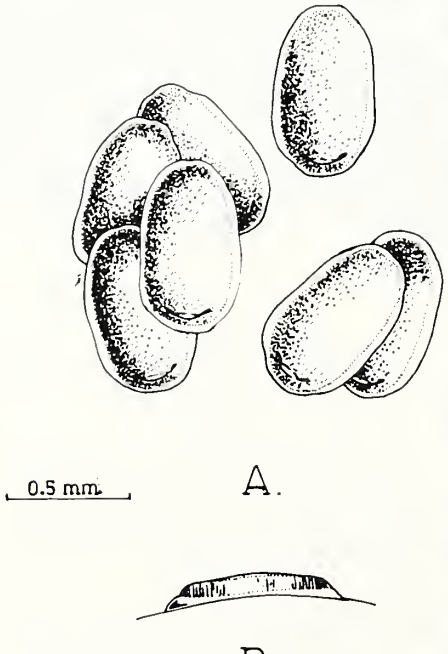

Fig. 2. Eggs of B. amydraula. A. Dorsal view. B. Lateral view.

Fig. 3. First instar larva of B. amydraula immediately after hatching (X 75).

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B. amydraula had 3 generations per year and the injury caused by its larvae has 3 peaks. However, the generations overlap. In the last generation the insect does not complete its whole life cycle. The larvae undergo an arrested state of development in the fibers at the base of the leaves and the remains of the dry bunches. This arrested state of development seems to be due to lack of food and unfavorable climatic conditions. The larvae overwinter until the beginning of the next period of fruit development. Overwintering larvae are purple and motionless (Fig. 5). During May, when temperatures are favorable and the new spathes are growing rapidly, the overwintering larvae resume growth and attack the fruit to complete their cycle. The first new generation starts by June and is the most dangerous; this infestation causes the highest percentage of fallen fruits. This may be due to the tenderness of the seeds and the fruits. The second generation occurs during July and August. Larvae of the third generation hatch about the end of August, feed and develop. By September they are ready to overwinter until the following May, when they attack the new crop and complete their life cycle.

Natural enemies. Hymenobosmina sp. (Fam. Ichneumonidae, Hymenoptera) was obtained in large numbers from **B. amydraula** cocoons reared in the laboratory from larvae collected in the field. Presumably, the parasite attacked the larvae in the field and completed its cycle in their bodies to produce the adults in the laboratory. The infested cocoon is characterized by being black and no moth emerges from it. The adult parasite is very active. This was the only parasite collected in numbers from **B. amydraula** during the course of this study. Apparently this is the first record from Sinai province of **Hymenobosmina** sp. as a parasite on **B. amydraula.**

Fig. 4. Pupa and cocoon of B. amydraula. Left, dorsal view of pupa; middle, ventral view of pupa; right, cocoon.

Fig. 5. Overwintering larvae collected during March, 1967, from the remains of dry bunches on date palm (X 4).

Table 1. Duration of different stages of B. amydraula under laboratory conditions during July and August 1966. Laboratory temperatures ranged from 28 - 34° C and relative humidity ranged from 62 - 72%. Under controlled conditions temperature was nearly constant at 25° C and relative humidity was maintained at 72.5% ± 2.5%.

Stage	Laboratory conditions		Controlled conditions	
	Time in days	Mean standard error	Time in days	Mean standard error
Incubation period	3	3.3 ± 0.81	4	
	4		5	5 ± 0.7
	5		6	
Larval stage	10		14	
	11	11 ± 0.55	15	
	12		16	
			17	
			18	
			19	17.9 ± 0.7
			20	
			21	
			22	
			23	
			25	
Pupal stage	12		14	
	13		15	
	14	14.25± 1	16	16.1 ± 1.4
	15		17	
	16		20	
	17			
Pre-oviposition period (females only)			1	
	2	2	2	2 ± 1
			3	
Adult longevity	3		5	
	4	3.4 ± 0.53	6	5.4 ± 0.69
	5		7	

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PRINCIPLES OF DATE PRUNING IN RELATION TO FRUIT THINNING

A. MIREMADI[1]

A previous study reported in 1970 (3) regarding determination of natural date fruit fall by counting at 3 different stages of fruit development, and also an earlier preliminary study on fruit thinning by bunch removal, tip cutting of the flower cluster and removing strands from the central bunches made at the Experiment Station of the Jundi Shapur University, College of Agriculture at Ahwaz, Iran, showed that date fruit fall poses a serious problem in Khuzestan. In the present study the percentage of fruit dropped from 6 tested date varieties varied from 38 to 74% during the 16-week period after pollination to harvesting time.

To improve quality and reduce fruit fall, thinning was necessary. A desirable thinning method, at least in the Khuzestan area, was bunch removal. However, El-Fawal (1) in Egypt, with Egyptian varieties, found that removal of tips of strands, central strands, and bunches resulted in an increase in fruit size and quality. These results, however, are not in agreement with our previous study concerning removing tips of strands and central strands. Because of the small number of palms tested originally we need to repeat the experiment with a larger number of palms and varieties in different locations.

The determination of a proper leaf-bunch ratio based upon varieties and bearing capacity is important for proper thinning practices in Khuzestan date culture. In this study the leaf-bunch ratio of 1050 twenty-five-year-old date palms consisting of 12 varieties was determined. The results indicate that the date palm in Khuzestan does not carry as many green leaves as it does in Indio, California (6,5,8,7). A clear explanation of this difference is not known. However, differences in cultivation, nutrient application, irrigation and other cultural factors may cause the premature death of the older leaves. Furthermore, according to the literature reviewed, the need for date pruning and its purpose seem to be different, as indicated by the totally different methods used in the two areas.

In the first part of this paper, the principles and practice used in date pruning in Khuzestan are described. In the second part, the importance of retained green leaves as a photosynthetic surface and the effect of their age in relation to thinning by bunch removal and to leaf-bunch ratio are compared with results obtained by Indio date research workers.

PRINCIPLES OF DATE PRUNING

In the United States, date pruning is done principally to provide better air ventilation to reduce checking or blacknose damage and is limited to removal of dead leaves and occasional green leaves. In Khuzestan, date pruning has the additional important function of maintaining tree health. There are several steps in the pruning practices followed.

Fig. 1. Unpruned date orchard with dead leaves hanging down.

Offshoot control. Limitation of the number of shoots is the first step of pruning. Date varieties vary in their ability to produce offshoots. Some may produce more than 12. If so many are permitted to grow, none of them, even after 5 to 7 years in connection with the mother palm, can reach a satisfactory size, length and weight for removal and transplanting to a permanent planting. In addition, a date palm having 12 offshoots would have a greatly reduced yield.

Growers apparently obtain best results when no more than 5 shoots are allowed to grow at one time. These should be spaced

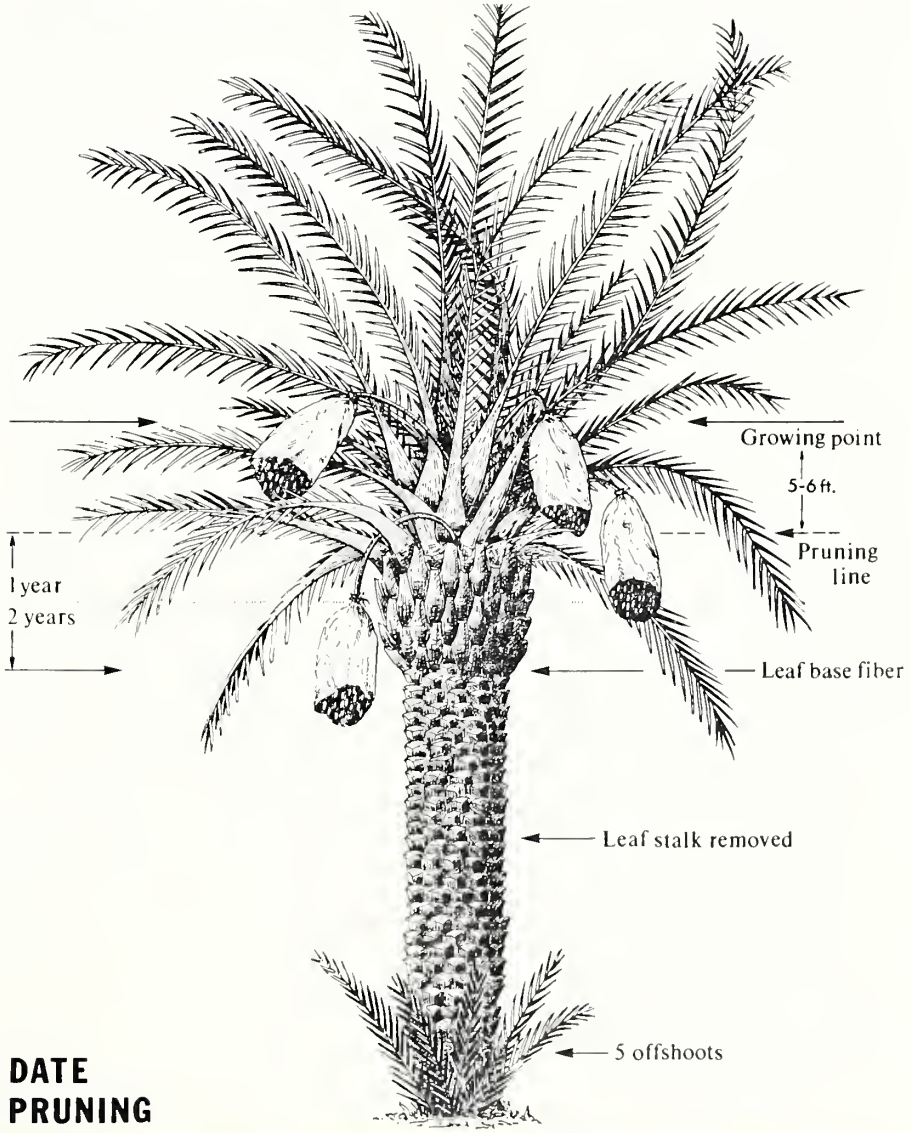

Fig. 2. Shows a diagram demonstrating principal rules of date pruning used in Khuzestan: limitation of offshoots, leaf stalk cleaned, leaf base fiber and the pruning line.

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at one-year intervals so that at the end of 5 years a shoot can be removed and a new shoot permitted to start. All stem (high) offshoots are removed. The time of removal for replanting is usually in the spring shortly after pollination.

Leaf pruning. All dead leaves and those hanging down are removed. Leaves based below the pruning line (Fig. 2), of which usually the terminal one-third or more is dead, are to be cut. At the time of pruning the leaf base should be green. If the leaf base is dead, it is believed that a fungus can enter and injure the main trunk of the palm: (4). Therefore under Khuzestan climatic conditions, if the leaf pruning is done regularly, a totally dead leaf will never exist, unless freeze injury occurs in a relatively cold winter. Fig. 1 shows an unpruned date orchard in which all dead leaves are hanging down. Removing leaves, even though they are green for about one-half to two-thirds of their length at pruning time, does not materially reduce the photosynthetic surface. Those leaves are at least 5-6 years old, depending on varieties and the age of date palm. In photosynthetic studies of palm leaves (7,8) reports indicate there is a gradual decrease of activity each year over a 4-year period. Therefore it is believed that leaves older than 4-5 years, if they are partly dead, would have little effectiveness.

Fig. 2 shows a diagram of the principal rules of pruning in Khuzestan, including horizontal pruning line, limitation of offshoots and stem cleaning. The distance of pruning line to the growing point of date palm, called "heart", is measured as 5-6 feet in the Saamaran variety at 25 years of age.

Removing leaf base and fiber. The most important and effective pruning step is removing the remaining leafbase including the surrounding fiber. In observations in Khuzestan many kinds of insects were found in the fiber surrounding the leaf base. This fiber keeps out spray materials and makes

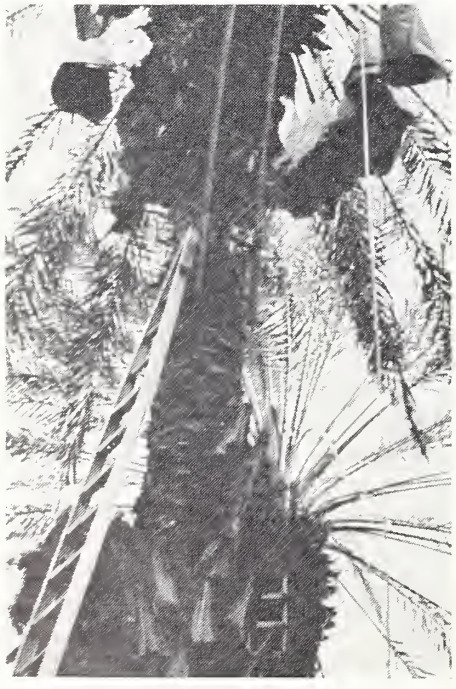

Fig. 3. Showing rotted and naturally removed leaf base from the trunk of date palm.

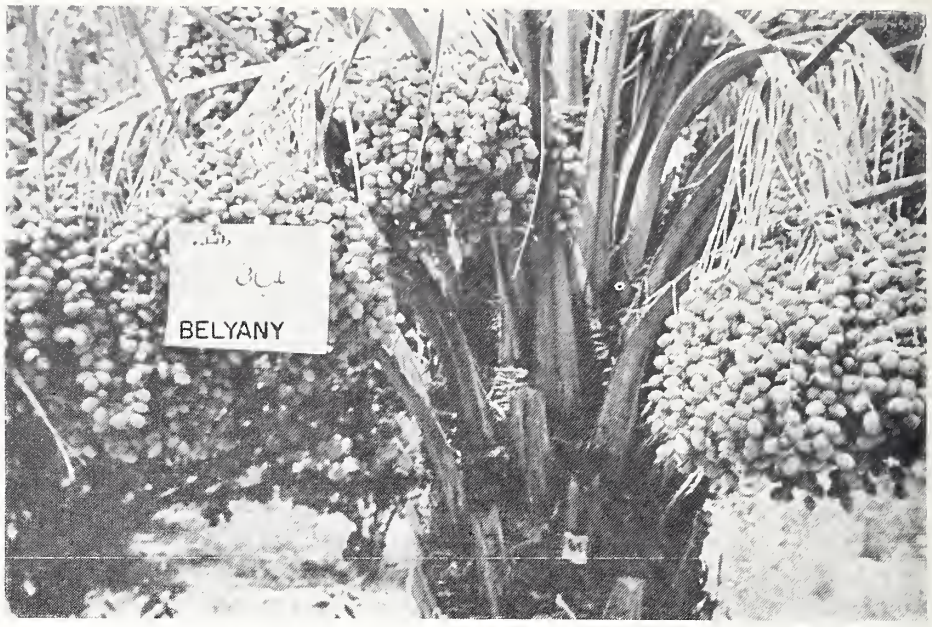

Fig. 4. Uncompleted pulling down of bunches on a small fruited variety Belyani.

a good place for insect activity. Therefore pruning is, in the date grower's opinion, necessary to protect the health of the date palm. So each year the leaf bases from the leaves pruned 2 years before will be cut close to the trunk, while they are still green. They can be removed with a special knife.

After this operation the trunk is clean and smooth, and the use of a climbing belt is easier.

As can be seen in Fig. 3, the leaf base in a relatively humid climate will decompose and fall. However, in Khuzestan it will remain as dead wood and make climbing difficult. Even though removal of the fiber and leaf base is customary in Khuzestan, there is still a question concerning the necessity of this operation.

Leaf cutting at the time of pulling down bunches. Some 8-10 weeks after pollination, when the date fruit begins to increase in size, the bunches should be pulled down through the leaves and tied. This operation may require 2 steps depending on the size of bunches and length of strands: in the first, after 8 weeks, the larger bunches are pulled down and tied; in the second, about 4 weeks later, the smaller bunches are tied down. At that time, because of serious interference with the bunches, 3 to 8 green leaves will be removed, the number depending upon variety, number of clusters and leaf compactness. This is the only time that green leaves are removed and the photosynthetic surface is reduced. Normal pruning removes only dead or partly dead leaves.

Fig. 4 shows the variety Belyani with the pulling down action only partly completed. Date varieties with relatively short fruit stalks are hard to handle. If the bunches are not pulled down, more than 50% of the fruit will be totally damaged or not saleable. Timing of this operation is important. Good management requires that the bunches be pulled down and tied.

Working hours required. As indicated, pruning is a major part of the cultural operation and requires considerable labor. Table 1 gives the amount of the labor required in each of the pruning steps on a per tree and per acre basis, calculated as 60 date palms per acre. Minimum and maximum requirements are based on different ages of the date palm. Unfortunately in most of the date plantations, the pruning is not properly done, and in some there is none.

In a properly pruned date garden the labor requirement for an unmechanized operation will depend upon age of the trees and will be approximately 35 to 50 man-

Table 1. Date pruning steps; maximum and minimum man-hours required per palm and per acre (60 palms/acre).

Pruning steps	Time of pruning	Max. and min. hrs. needed/palm	Working hrs. per acre
Offshoot control	March-April	1-1.5	60-90
Leaf pruning (15-20 leaves)	April-May	1-1.5	60-90
Leaf stalk and fiber (15-20 leaves)	Any time	1.5-2.5	90-150
Pulling bunches down	June-July	1.5-2	90-120
Totals		5-7.5	300-450

days of labor per acre.

It is important to conduct further studies to determine how much of the customary pruning process is really necessary and how much the enormous labor requirement could be reduced by an intensive pest and biological control program as well as by using stationary ladders fastened to the trunks.

PRUNING IN RELATION TO THINNING

The green leaf is the base of the photosynthetic surface of the date palm and the bearing capacity is in proportion to the number of leaves. Fruit thinning, especially bunch removal, is also based on the number of green leaves. This number, however, varies with cultural practices, variety characteristics, the age of the palm and also the method of priming. In California, according to Nixon (6), the Deglet Noor palm, 15 years old, unpruned and under good growing conditions, carries an average of 183 green leaves. His recommendation was to reduce the number to 140-150. In Khuzestan, after a regular pruning, as indicated, the date palm carries an average of 50-80 green leaves (4).

A study was conducted in 1968 to determine the leaf-bunch ratio and the total number of green leaves on 1050 palms consisting of 12 varieties. The investigation shows the following leaf-bunch ratios:

> Kabkab 10.2, Zahidi 9.6, Saamaran 9.3, Davri 8.6, Khadrawy 8.5, Halawy 8.1, Belyani 7.2, Shirani 6.8, Gantar 6.5, Dagelmussa 6.0, Dagelzard 4.1 and Dagelsorkh 3.8.

The number of green leaves in this study varied from 32 to 108, with a range of 7 to 12 bunches per palm. Because of the alternate bearing tendency and changing number of flower clusters from one year to another, data may differ from year to year. However, the enormous range in leaf-bunch ratio, from a minimum of 3.8 for Dagelsorkh to a maximum of 10.2 leaves per bunch for the Kabkab variety, gives an idea of the existing variation. Furthermore, there was no exact relationship between weight of bunches and the leaf-bunch ratio; so bunches with 10 leaves as a photosynthetic surface did not have a greater weight than bunches having 4 leaves. Fig. 5 shows a crown of Dagelsorkh variety with 8 bunches and only 32 young leaves. The weight of bunches of this variety ranges from 6 to 8 pounds, not as low as would be expected from a low leaf-bunch ratio of 4. This might be explained by two factors, namely, the number of flower clusters and the yield capacity, both of which are variety characteristics.

How far the leaf-bunch ratio can be used as a guide for bunch-removal thinning is not clear. According to a pruning study (8) on Deglet Noor, a limitation of green leaves to 100, 125 or 150 produced no significant difference in the total production over a 5-year period. In the same report where a leaf-bunch ratio ranging from 3-15 was used, the highest yield was with the ratio of 7.5. This was not significantly different, however, from the ratio of 9. Nevertheless the leaf-bunch ratio, as Nixon (8) indicated, might be relatively useful in estimating the crop that can be carried by each date palm of each variety.

Fig. 5. Dagelsorkh variety carries 8 bunches on just 32 leaves, 1 and 2 years old.

The number of green leaves in Khuzestan, because of several factors as indicated, is limited and the total green leaf area is approximately 50 to 60% of the amount reported in Indio, California (2,5,6,8). Since Mathez, et al. (2) reported the leaf-bunch ratio and the leaf-fruit ratio to be important in Indio, it seems reasonable to use this method of comparing the leaf-bunch ratio and leaf-fruit ratio as determined from a 5-year study in Khuzestan as a guide for bunch removal thinning.

SUMMARY

In connection with a previous study for determination of natural fruit fall of date palms in Khuzestan, a study was conducted to determine the leaf-bunch ratio without any thinning of the 1050 date palms of 12 varieties at the Experiment Station of Jundi Shapur University, College of Agriculture at Ahwaz, Iran. A review of the literature shows the enormous difference between the number of green leaves carried by date palms in Khuzestan and those in California.

The number of green leaves remaining on the tree is closely related to the pruning method. The pruning method used in Iran is totally different from that used in California. The 4 steps of pruning in Iran are: offshoot control, leaf pruning, removing leaf stalk and fiber and leaf cutting when pulling down bunches, including time and labor requirement. Removing leaf stalk and fiber, which require a large number of working hours, needs further study. It may be possible to eliminate this step by intensive pest and biological control.

The lowest leaf-bunch ratio tried was 3.8 for Dagelsorkh variety; the highest, 10.2 for the Kabkab variety. Contrary to expectation, the weight of bunches of the lower leaf-bunch ratio (3.8) was not less than the weight of bunches with 10.2 leaves. This may mean that variety characteristics have more influence on the amount of yield than does the number of leaves per bunch.

It is proposed to continue this experiment on a larger scale and in different locations to determine the number of naturally emerging bunches with relation to the number of retained green leaves for each variety. Furthermore, it appears necessary to make an additional study on a larger scale involving cutting back the strands, removing central strands as well as bunch removal thinning to produce better quality fruit and reduce the excessive fruit fall.

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OBSERVATIONS ON DEGLET NOOR DATE PRODUCTION IN ALGERIA

G. L. RYGG[1]

Deglet Noor is not the most extensively grown variety of date produced in Algeria, but it is the only important variety grown for export. Although many other varieties are grown, the current trend is for most of these to be replaced by Deglet Noor, Rhars, and a very few additional varieties. Wherever it is adapted to the soil and climatic conditions, Deglet Noor is preferred because of its importance in the export trade and, therefore, its favorable effect on the balance of trade. In recent years, Deglet Noor has constituted 40% of the total date production in the Department of Aures, in which Biskra and Tolga are located.

Accurate information on the productivity of Algerian date gardens is difficult to secure. Values ranging from 5 to 440 lb. per palm have been stated. A realistic view of overall average production suggests values ranging from 28 lb. to 35 to 45 lb. per palm. Total production is estimated at 110,000 tons, but this value is only an estimate, as many growers refuse to divulge their yields and the amount withheld for domestic consumption during the year. The land area devoted to date growing in Algeria is about 40,000 ha, or 100,000 acres. One-third of these plantings are in Aures.

CULTURE

Interplanting has been a common practice for many years. Three layers may be grown: a top layer of dates; a middle layer of deciduous fruits such as apricots, peaches, figs, pears and apples; and a lower layer of vegetables. This arrangement produces intense competition for water, fertilizers, and light, and an unfavorable humidity situation for the developing and ripening dates. None of the newer Deglet Noor plantings are interplanted.

In date gardens that are not interplanted the practice of non-tillage is universal. Grass is grown for pasturing cattle, sheep, goats, and donkeys. Irrigation furrows are lined with **Agropyrum staphilatum,** a coarse grass used to control erosion, which is passed over by the grazing animals. Another grass, the dees, presents a serious problem wherever it has become established. It is difficult to control, and animals refuse to eat it.

Tree spacing and irrigation. Irrigation is adequate in the best gardens. Palms in these gardens are well spaced at 9 to 10 m, or about 30 ft., in each direction, and are irrigated in furrows, as commonly practiced in the United States. A normal application of water is said to be about 3 m per year. Many gardens receive much less than this amount of water, and the palms in the older gardens are frequently spaced irregularly and closer than 3 m apart. Clusters of 3 to as many as 5 large palms are common in some of the older areas such as Sidi Okba, southeast of Biskra. A common irrigation practice is to apply water 4 times in a summer. The amount applied each time is unknown, even to the grower, but this water supplies the interplanted crops and the grazing crop in addition to the dates, where these crops are grown.

Water, or lack of it, is the principal limiting factor in Algerian date production, and most authorities agree that no additional land should be planted to dates unless an equivalent area is removed from cultivation. Some Algerians believe there are already more date plantings than can be adequately watered. The Atlas Mountains immediately north of the Sahara Desert provide the irrigation water. All the streams are dammed, and the impounded water is conserved for irrigation, domestic use, etc. Higher dams to replace some of the older ones are contemplated so as to increase the storage capacity. This will be useful in seasons of heavy run-off, but years of minimum run-off constitute the limiting factor for planting. All the streams usually go dry in summer.

Palms in many of the older plantings and those on canyon slopes are much closer than 3 m and are very irregularly spaced. Proper watering is difficult or impossible under these conditions. To convert these gardens to well-spaced plantings with moderate slopes, the old palms must be completely removed and the soil leveled before the new offshoots can be planted. This is an expensive operation and the private operator must receive considerable financial assistance until the new plantings become productive.

The supply of offshoots, especially of Deglet Noor, is limited, particularly since the imposition of a quarantine on shoots from areas infected with, or suspected of being infected with, bayoud. These areas include Touggourt and other important oases.

Fertilization. Fertilization programs are generally minimal, but some of the commercial growers are said to apply commercial fertilizers. Organic fertilizers are applied by growing grass, grazing livestock, and allowing Bedouins to place their tents in the gardens so the refuse will be applied to the soil. Plans call for the increased use of commercial fertilizers, applied according to experiment station recommendations.

Bunch management. Deglet Noor fruiting is restricted to 12 bunches per palm, and in the better gardens the size of the bunches is reduced by removing some of the center strands. The ends of the strands are not customarily cut back.

Pollination is said to be accomplished by blowing pollen through tubes to the vicinity of the flower clusters. A more positive placement should improve fruit set, although the current practice should be as effective in pollen placement as pollinating from aircraft, as is increasingly practiced in the United States. Inasmuch as the workers do not climb the palms to pollinate, at least partly for lack of adequate manpower, it is unlikely that the growers can be induced to cut back the strands, since these two operations are normally accomplished at the same time.

Smaller growers are supplied with plastic bunch covers, which are usually perforated. Larger growers were unable to secure these covers, even by purchase. The covers used in 1970 were received too late for timely application.

Some growers refuse to use plastic covers because they injure the fruit by raising the humidity around it. Kraft paper covers such as are used in the United States are not available to the Algerian growers, nor have they been tried experimentally.

The fruit strands, being full length, extend well below the bunch covers, thus exposing the lower fruit to rain injury and attack by birds, a major problem in Algeria. Lengthening the covers or shortening the strands should be helpful in reducing this kind of loss.

Pests and diseases. Various pests and diseases attack dates in Algeria. Parlatoria scale constitutes a problem, at least in some areas. Graphiola leaf spot is of some importance, and 6 new chemicals are currently being investigated at one of the experiment stations in an attempt to develop a control. Bordeaux spray does not control the disease satisfactorily. The bayoud disease is threatening the Algerian date industry and is the subject of a separate report today.

Birds that attack the ripening and ripe dates are said to cause an average of 2% loss each year.

A new pest of much significance in 1970 is the rodent **Mus sylvaticus intermedius.** It climbs the palms and damages large quantities of dates just before and during harvest. To minimize the loss from this rodent and the bird pests, the grower must harvest the fruit earlier than desirable from the point of view of fruit maturity. It is also necessary to remove all the fruit in one picking because the reduced amount left in the trees after a partial harvest becomes the target for concentrated attack by these pests.

I saw few date insects in 1970, either in the gardens or in the packing houses. No special effort to control them outdoors was noted. Countless flies were present wherever people gathered to work outdoors or at the receiving stations, but practically no flies were noted inside the packing houses.

HARVESTING

All Deglet Noor harvesting, with minor exceptions, is accomplished by workers climbing the palms, severing the bunches, and lowering them to the ground with ropes. Here they are transferred to mesh-bottom trays about 1 by 2 m, large enough to hold a load for 2 men, who carry them to a central area where the dates may be removed from the bunches and placed in boxes, or they may be loaded onto trucks and hauled to a central receiving station if they are destined for the processing and packing plants.

The cut bunches usually have a considerable number of dates in the khalal stage of maturity, or just past this stage. On arrival at the central receiving station these bunches are hung in 5 tiers in open-sided buildings at prevailing outdoor temperatures

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up to a month while the fruit continues to ripen and cure. The dates are removed periodically as they ripen until all are removed. Strands with excellent quality dates are cut with the dates attached and taken to the packing house for separate handling and packing.

Bunches that are to be stripped in the field are deposited on plastic sheets spread on the ground to prevent the dates from being soiled. Workers are seated on the ground to pick the dates off the strands and place them in containers according to maturity. These dates are usually taken to local markets. Large numbers of intact bunches are also taken to local markets and other domestic markets. Tourists buy them and carry them to airplanes as they leave for home, and of course the local people buy them in large numbers.

Dates are hauled from the gardens to the local markets or to the central receiving stations by donkey-back, donkey-drawn carts, bicycles, scooters, motorcycles, or motor trucks. The larger growers use motor trucks.

PACKING HOUSE OPERATIONS

Algeria has 4 new modern, well-equipped packing houses. They were ready for use in 1969, but as that crop was totally destroyed by rain, the houses were first used in the fall of 1970. I visited 2 of these. These houses have excellent facilities for washing, conveying, fumigating, processing, and storing dates, as well as modern machines for wrapping date packages with plastic film.

On arrival at the packing house the detached dates are washed in large cylindrical washers. These are of perforated metal and are operated in a slightly inclined position. Jets of plain water strike the dates and remove the dust and soil. The dates then flow onto plastic conveyors to graders, who separate them into 3 or 4 grades, based on hardness or dryness. Each grade is processed at a temperature and for a time chosen according to need. The temperature range is 65° to 70° C (149° to 158° F) at 55% relative humidity; the time range is 2 to 4 hr. After a suitable length of processing the dates are dried in the same chambers at 70° C (158° F) 1 hr. The product has excellent flavor, texture, and color. The moisture content, as estimated from the consistency of the fruit, was probably close to 20%.

For processing, live steam and dry hot air are introduced into the chambers in appropriate proportions to produce the desired conditions. For the last hour the application of steam is discontinued, but hot dry air is blown through the chambers.

After processing, the dates are graded once more, this time for size. The smallest and hardest fruit is sold locally, and the remainder is packaged for sale in the cities and for export.

In one house the processing treatment was considered ample for insect control; in another all the dates were said to be treated with ethylene oxide on arrival. This was accomplished by placing the dates in large vacuum chambers, drawing a vacuum of 720 mm, introducing the ethylene oxide, and holding for 1 hr at room temperature. It should be pointed out that ethylene oxide treatment of dates is no longer permitted in the United States.

All the equipment in the packing houses is strictly modern and of excellent quality. Containers are of plastic and are readily cleaned. The processing rooms have excellent temperature and humidity controls. Washing water is not recirculated, and no detergent is used. The entire packing house operation is directed by an experienced and skilled supervisor from the Marseilles packing houses, where Deglet Noor dates from Algeria have long been successfully processed.

The finest dates are packaged without processing, while still attached to the strands. The dates are hand-brushed and hand-placed in long plastic bags or in long fiberboard boxes, and then placed in master cartons. These dates are shipped to France, stored until the holiday season, and sold to the British.

Processed dates of the better grades are packed in 250- and 400-gram fiberboard boxes which are overwrapped with plain cellophane. The dates are place-packed by hand.

Lower quality dates, often packed in large baskets, are sold in local markets.

STORAGE AND DISTRIBUTION

Dates that are to be held for a relatively short time are stored at 7° C (45° F), but those held for long periods are stored at -1° to -2° C (28° to 30° F).

The finest Deglet Noor dates, except for those marketed on the strands, are sold in Algiers, where a higher price is received than in France, where much of the remainder is sold. The French prefer the somewhat sticky processed dates, whereas the British prefer the dry-surfaced unprocessed ones. Of the exported dates, 40% are sold in France; the remainder in the United Kingdom, Scandinavia, Italy, and eastern Europe. Algeria expects to find markets in these countries for all the dates it will be able to export now and in the future.

The lower grades of Deglet Noor dates and practically the entire crop of the other varieties are sold in the domestic market. This fruit is an important staple food for the Algerians.

NOTES ON BAYOUD DISEASE OF DATE PALMS IN ALGERIA[1] [2]

J. B. CARPENTER[3]

A visit to Algeria in September and October 1970 provided the opportunity to obtain firsthand information on the bayoud disease, or fusariose of date palm (**Phoenix dactylifera** L.) caused by the fungus **Fusarium oxysporum** Schlecht. var. **albedinis** (Kill. & Maire) Malencon. Bayoud is the most important disease of the date palm and was observed before 1890 in the Draa Valley of Morocco. The disease spread rapidly and ruined date culture in Morocco, south of the Grand Atlas Mountains. Benzaza et al. (4a) discussed the early history of bayoud in Algeria, where the disease was first identified at Beni-Ounif in 1898; Colomb Bechar, 1900; Beni-Abbes, 1908; Sillafen, 1910, and Fatis, 1912 (Fig. 1). Bayoud spread eastward in west-central Algeria, and by 1949 date palm plantings at Metlili were infested and the losses there are now reported to be severe. By 1965, bayoud had spread to the oases centered on Ghardaia, about 70 km (42 miles) north of Metlili (Fig. 1). The disease is now widespread in that district at the entrance to the great oases centered on Ouargla, Touggourt and Biskra. These oases, which are estimated to contain more than 2,500,000 bearing female palms, produce most of the dates for the domestic markets of northern Algeria and for the export market, as well as supplying dates for local consumption. Bayoud continues to spread in both Algeria and Morocco. Fortunately, the disease was not introduced into the United States with early importations of foreign date palm varieties, and enforcement of quarantine laws has prevented its subsequent introduction.

Reviews of the literature on bayoud (1, 2) may be consulted for further details of the disease. The investigations of Toutain (5, 6) provide information on cultural factors affecting bayoud and long-term investigations on selection of bayoud-tolerant date palm varieties. A recent report of the Algerian Government (4a-f) included papers on surveys for bayoud disease and on a disorder that may represent an atypical expression of bayoud. This latter disorder is of special interest to date growers, since it may represent an unidentified form of bayoud. Included here are references only to recent literature and notes made during a week's tour of oases at Ghardaia, Ouargla, Touggourt, and Biskra.

In spite of the effort of Government agricultural agents, infected palms are seldom eradicated immediately, especially in waste land or abandoned plantings. Within 5 to 10 years, bayoud will probably ruin date culture around Ghardaia, with an area of small, family-plot type of agriculture.

Brochard and Dubost (4b) and Hethener (4d) suspect that bayoud may be present in an atypical, mild form in date palms in other parts of Algeria. They have located palms affected with "atypical bayoud" at Zelfana, about 40 km east of Ghardaia, and in 3 orchards at Moggar, Sidi Slimane, and Ghamra in the Touggourt oases (Fig. 1). The disorder in these palms has neither the external nor the internal symptoms of typical bayoud. The normal color of the palm leaf becomes dull, commencing with the lowest leaves; pinnae begin to die at the tips and may be somewhat appressed to the rachis. Although most palms appear to recover from the disorder within several months, some die. When the palm is still in the earliest detectable stages of the disorder, young offshoots may die while attached to the parent palm. Internally, the discolored and fungus-invaded tissues are localized in the base of the palm. There is no apparent movement of the fungus into the central trunk and upper bud zone; and no traces of infection have been found in leaf rachises, as is common in typical bayoud. The number of affected palms has increased in the affected orchards. In the same orchards, chance seedlings 1- to 3 years old wither and die for no apparent reason. Fungi, morphologically indistinguishable from F. **oxysporum** var. **albedinis**, have been isolated from affected trees, and some of these isolates have caused infection in very young date seedlings (personal communication).

In an orchard of 'Deglet Noor' and 'Rhars' palms at Zelfana, the Algerian pathologists and I dissected a 6-year-old tree of Deglet Noor showing "atypical bayoud" symptoms in the foliage and one small dead attached offshoot. A small lesion consisting of dark tissue surmounted by a limited area of discolored vascular bundles was found in the parent tree. Freshly cut vascular tissues were stained the rosy-brown color seen in typical bayoud-infected trees. This orchard has been surveyed periodically and the disorder appears to be spreading. The behavior of young chance-seedling palms is noted and extensive soil sampling is employed to study the fungus pathogens of date palm that may be present. The

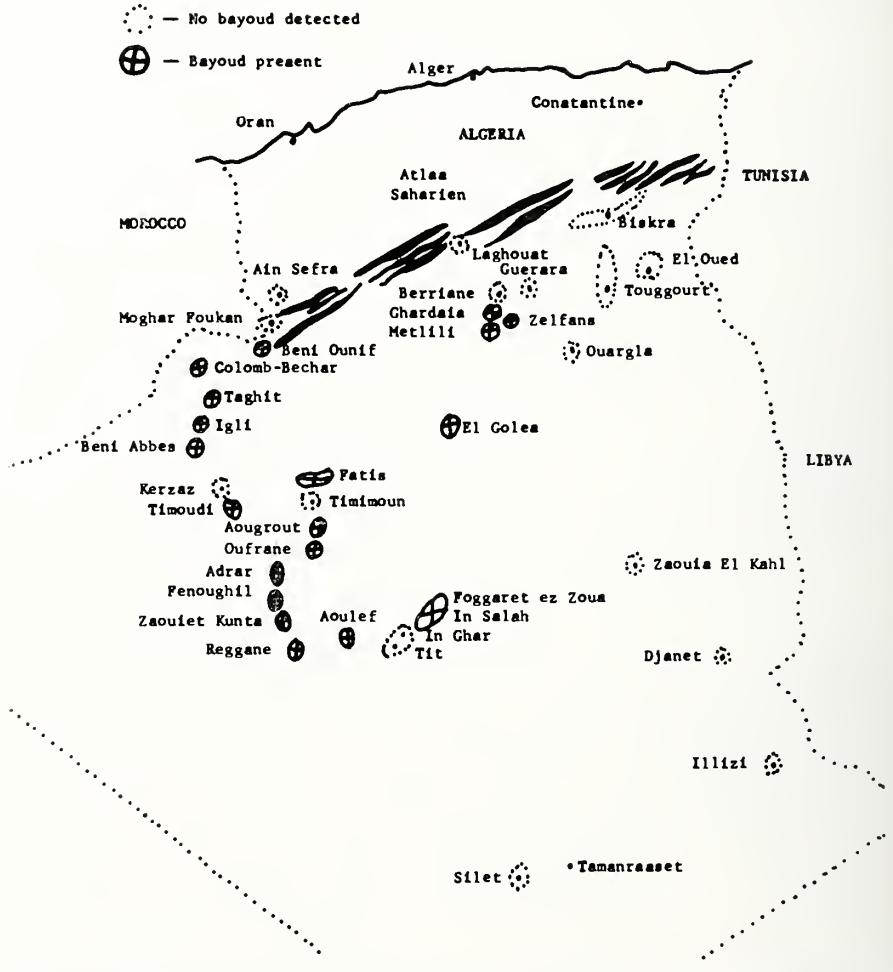

Fig. 1. Distribution of bayoud among the principal date palm oases in Algeria through the year 1970. Redrawn from "Progression du bayoud en Algerie et resultat des prospections entreprises" (4a) by permission of the authors.

[1] Grateful acknowledgement is made to P. Brochard, D. Dubost and P. Hethener, Laboratoire Anti-Bayoud, Sous-direction de la Protection Vegetale, Ministere de l'Agriculture, Algiers, Algeria; to E. Y. Laville, Institute Francaise de Recherche Agronomique, Paris, France; and to J. Louvet, Institute Nacional de la Recherche Agronomique, Dijon, France, for generous and valuable assistance in studying the bayoud disease.

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[3] Plant Pathologist, Plant Science Research Division, Agricultural Research Service, U.S. Department of Agriculture, Indio, California, 92201.

Algerian investigators will retain certain affected trees and observe them for an extended period to learn whether typical symptoms of bayoud develop. Also, they will plant large numbers of palm seeds around affected trees and observe the seedlings for evidence of attack by the bayoud pathogen.

While the affected trees in Zelfana appeared diseased, trees observed at Moggar resembled palms suffering from poor cultural conditions. The orchard soil was extremely dry, underlaid with a thick gypsum hard pan, and contained substantial amounts of salt. No palms were dissected at Moggar.

Typical bayoud, and perhaps the atypical form, are grave threats to the Algerian date industry. Personnel at the Anti-Bayoud Laboratory are making every effort within their limited means to study the problem and prevent invasion by bayoud into oases currently free of the disease. Movement of soil and live plant material from bayoud-infested areas to non-infested areas is prohibited by law, but enforcement is reportedly ineffective.

All of the principal date palm varieties in Algeria are susceptible to bayoud. Long-range control of this disease appears to depend upon development of bayoud-tolerant date palm varieties (2, 3) for replanting of devastated areas, and for new plantings in areas where invasion by bayoud is a potential threat. Tunisia, although still free of bayoud (3), cooperates with the Government of Moroceo in testing varieties for tolerance to bayoud (6).

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TRICKLE IRRIGATION OF DATE PALMS[1]

O. REUVENI

INTRODUCTION

The irrigation method known as "drip" or "trickle" irrigation, which was developed in Israel and adapted there for use in the field, is being widely used for annual crops especially in arid regions with highly saline water. In contrast, this method is still at the experimental stage as far as perennial crops are concerned, and very few commercial plantations are trickle-irrigated. A detailed description of the method, its principles, advantages and possible hazards, has recently been published in 2 articles (1, 2) and will therefore not be discussed here. I will mention only points which may be of specific advantage in irrigating dates: (a) Since the number of palms per unit area is small, installation costs per unit area are relatively low when compared with other crops. (In Israel the average cost per running meter of a trickle irrigation system, including filters and fertilizer applicators, is between IL. 1.30 and 1.50. [$1 = IL. 3.50]) (b) Weed growth is limited because only part of the total area is wetted, thus making chemical control easier and cheaper. (c) One might expect lower relative humidity in the garden because there are fewer weeds and only part of the area is wetted (in comparison with gardens where all the ground between trees is wetted). This is an important factor at the time of fruit development and ripening.

The objective of the present experiment was to test whether palm trees can be grown using trickle irrigation, i.e., by wetting a relatively small area between trees. Included herein are the results of the first 2 years of an experiment which is due to continue for a number of years.

MATERIALS AND METHODS

The experiment is being conducted in a Deglet Noor garden at Yotvata, planted in 1958. Planting distances are 10 x 10 m (1 foot = 0.305 m), on a sandy loess soil. The garden is now in full bearing and its development may be rated "above average". In the early years the garden suffered from irregular irrigation and from salinization in 1965, which caused a setback for a couple of years. The water table varies in depth during the season from 1.50 - 1.80 m. and the salinity of this ground water reaches 8000-10,000 mg chloride/l (approximately ⅓ of total salts in the water is chlorine). Water used for above-ground irrigation is pumped from local wells and is diluted to a constant salinity of 550-600 mg chlorides/l throughout the year.

The experiment is being conducted on 180 trees planted in 10 rows of 18 trees each in a N-S direction. The area is divided into 2 blocks of 5 easterly and 5 westerly rows. Each block is divided into 3 plots, each consisting of 5x6 = 30 trees. Thus each block has a northern, a central and a southern plot. One plot in each block is irrigated by one of the following 3 methods: (a) one line of tricklers along each row (O); (b) 2 lines of tricklers along each row (T); and (c) sprinkling which wets the entire surface between trees (S). Data are recorded from the 12 central trees in each plot, leaving one tree as margin at the edge of each plot.

Since there are in fact only 2 replicates in this experiment, a number of comparisons between trees were made before the start of the experiment to determine differences between the plots. These are shown in the results. The design of this experiment was dictated by the number of trees and the means available for the work. In spite of this defect, it seems that the results may be regarded as reliable, since 24 trees are being examined in each treatment.

The filters and tricklers are manufactured locally by "Technoram." The distance between tricklers (discharge rate: 10 l/h) is 75 cm, and 12 tricklers supply each tree on each tube, i.e. in O and T, 12 and 24 tricklers per tree, respectively. The area wetted by a trickler had a diameter of 1.2 m, there being full overlapping between 2 tricklers on the same distribution tube. In T, the distance between tubes is 1 m, giving full overlapping between the 2. Sprinkled trees were irrigated 3 times a month from the beginning of March through August; twice a month in September, October, November and February; and once a month in December and January.

The trickle system was installed at the end of summer in 1968. Up to July 1969 the trees were trickle-irrigated at the same intervals as sprinkling was carried out. Since July 1969, O and T trees have been irrigated twice a week throughout the year. The total amount of water given in 1969 and 1970 was 150 m^3 per tree. The quantity of water given is controlled by control valves and in addition, the actual quantity delivered is measured. Small errors which slip by the control valve are corrected at the following irrigation.

The quantity of water given at sprinkling is calculated to equal the quantity given by trickling in the interim period since the last irrigation. The amounts of water to be given were calculated in advance for the different months of the year, by multiplying the average evaporation from a Class A pan (as measured over a few years) by the factor 0.4. This relatively small amount of water was given on the assumption that the trees receive part of their requirement from ground water, and because this garden was irrigated in the past with a total quantity of 160 m^3 per tree per annum.

In the middle of summer, when fruit checking is a hazard, sprinklers are covered with tin cans, so that water is distributed only between the trees. In both years, under all 3 irrigation regimes, irrigation was stopped a week before the beginning of harvesting and was resumed only after harvesting was concluded (from mid-October to the end of the month).

Trickle-irrigated plots were fertilized through the system; sprinkled plots were fertilized by regular surface application. In 1969 and 1970, only nitrogenous fertilizer was applied, at an annual rate of 7.5 kg ammonium sulfate per tree. In 1969, sprinkled trees received fertilizer 3 times, in March, May and November; trickle-irrigated trees were fertilized 7 times, in January, April, June, July, August, September and November. In 1970, sprinkled trees were fertilized 4 times, in February, May, July and November and trickle-irrigated plots were given small quantities of fertilizer once a week (except during October), at the following rates: from January through June a total of 1 kg/tree was given; during July, 2 kg/tree; and the remaining 4.5 kg were applied during the rest of the year at different monthly rates, relative to the quantities of water applied.

Bunches were thinned by strand shortening and removal of central strands, with the objective of obtaining 800-1000 fruits per bunch at harvest. Thinning was done close to and after bunch tying. In 1969, the number of bunches on the tree was also reduced; in 1970, all bunches were left on the trees.

Measurements, analyses and calculations

Measurements and analyses were made as follows:

Leaf analysis: Five pinnae were sampled from each side of the rachis in the center of a 1-1½ year-old leaf. Seven trees were randomly sampled in each plot in mid-June of 1968. In 1969, six trees were sampled in mid-April; in 1970, all 12 trees were sampled in each plot in mid-April.

Elongation of Spike Leaf and Leaf Production

Elongation of the spike leaf was measured once a month; at each date, a different leaf was measured. Elongation rate is expressed as the average daily rate. On the day of measurement, the number of leaves produced since the previous measurement was also recorded.

Yields. In 1969, only fruit weights were compared. For this purpose 50 fruits were randomly sampled from each bunch on the experimental trees of each plot. In 1970, the yield from each tree was weighed separately, after which 100 fruits were randomly sampled from every bunch, and weighed and graded. From these data, the average weight per fruit was calculated, as was the percentage of fruit in each grade (percentage of culls is not presented here).

RESULTS AND DISCUSSION

1. No significant differences among trees in the various treatments were found in 1968, the season before the experiment, as far as leaf mineral content and the number of bunches picked are concerned (Table 1 and 2). One can therefore ascribe the differences found in subsequent years to the treatments given.

2. The most marked difference in leaf analyses between sprinkled and trickle-irrigated trees was the nitrogen content of the leaves (Table 1). The lower value found in trickle-irrigated trees may have been due to greater leaching of this element following the frequent irrigations given under this system. In view of this finding, it was decided to apply small quantities of nitrogen throughout the year (except during fruit ripening). This has been done since July 1970 and the amount of fertilizer applied is relative to the amount of water given at each irrigation. In 1971 the total quantity

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[1] Contribution from The Volcani Institute of Agricultural Research, Bet Dagan, Israel. 1971 Series No. 1944 -E.

Table 1: Fresh weight, dry weight and mineral composition of pinnae of date palm trees irrigated by one trickler pipe (0), 2 trickler pipes (T), or sprinklers (S).

Year	Treatment	Fresh Weight	Dry Weight	% Dry Weight								ppm				
		gr /	pinna	Ash	SiO_2	N	P	K	Ca	Mg	Na	Cl	B	Fe	Zn	Cu	Mn
	O	7.73	4.22	11.1	8.9	1.45	0.08	0.69	0.30	0.20	0.007	0.90	147	88	8	13	48
	T	7.41	4.05	10.1	7.8	1.41	0.08	0.72	0.29	0.21	0.007	0.95	155	83	9	13	47
1968	S	7.53	3.94	10.7	8.3	1.44	0.08	0.77	0.30	0.20	0.007	0.97	126	83	9	14	61
	Significance°	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	O	7.74	3.78	8.2	5.7	1.38	0.09	0.74	0.29	0.26	0.005	0.83	104	88	13	14	93
	T	7.66	3.73	8.4	5.7	1.37	0.09	0.80	0.30	0.27	0.005	0.82	104	81	14	11	102
1969	S	7.12	3.44	7.6	4.9	1.41	0.09	0.89	0.27	0.26	0.005	0.88	126	77	12	11	106
	Significance°	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	OT/S	NS	NS	NS	NS
	O	6.57	3.26	9.5	7.3	1.35	0.09	0.64	0.29	0.23	0.009	0.80	121	60	13	11	86
	T	6.21	3.00	11.0	8.8	1.26	0.08	0.64	0.30	0.22	0.011	0.84	120	64	13	10	109
1970	S	5.32	2.71	10.2	7.9	1.48	0.08	0.61	0.29	0.23	0.010	0.76	239	80	12	10	125
	Significance°	O/T/S	O/T/S	O/T/S	O/T/S	O/T/S	NS	NS	NS	NS	NS	NS	OT/S	NS	NS	NS	O/T/S

° NS = No significant difference among the 3 treatments.
O T/S = Significant difference between treatments to the left and to the right of the stroke.
O/T/S = Significant difference among the 3 treatments.

of nitrogen applied per tree will be raised and potassium will also be given (since low values of K were found in leaf analyses of all treatments).

3. Table 2 shows that in both 1969 and 1970 no significant differences in inflorescence production or bunches harvested were found among the 3 treatments. The situation was different in the case of vegetative growth as measured by the number of new leaves produced (Table 2) and the rate of spike leaf elongation (Table 3). As seen from the 2 tables, vegetative growth was greater in trickle-irrigated trees than in sprinkled ones. Comparing the 2 trickling treatments, one pipe per tree seems to produce slightly better results than 2.

4. In 1969, the yield per tree was not weighed. As there were no differences between the number of bunches picked (Table 2) and the average weight per fruit (Table 4), it may be concluded that there was no significant difference in yield among the 3 treatments. However, even in the first year a trend toward larger fruit was evident in trickle-irrigated trees. The appearance of these fruits was generally better, as expressed in a lower percentage of dry fruit.

In 1970 a large and significant difference in the size of fruits was found in favor of trickle irrigation. No differences in fruit size were found between one and 2 pipes of tricklers (Table 4). The difference in absolute yield values found between treatments may be explained by the different number of bunches harvested and by the weight of a single fruit. If we make a hypothetical calculation of yield per tree assuming a uniform number of bunches per tree in all 3 treatments (let us take 10 bunches), and the weight of a single fruit as it appears in Table 4, the expected yield would be 61, 75 and 78 kg per tree under sprinkling, 2 trickler pipes, and one trickler pipe per tree, respectively. This calculation, though artificial, may be made and it shows that the advantage of one pipe of tricklers over 2 pipes does exist, but is probably not so great as it appears in Table 4. There is, however, no doubt at all that trickle irrigation has a great advantage over sprinkling.

GENERAL DISCUSSION

The objective of this experiment was to determine whether it is possible to grow

Table 2. Annual leaf production, number of inflorescences flowering, and number of bunches harvested per date palm irrigated by one trickler pipe (O), 2 trickler pipes (T), or sprinklers (S).

Year	Parameter (number per tree)	Treatment O	T	S	Significance*
1968	Bunches	11.7	11.5	12.2	NS
1969	Leaf production	29.4	28.6	25.8	OT/S
	Inflorescences	14.7	15.4	15.7	NS
	Bunches	12.0	13.3	12.5	NS
1970	Leaf production	24.4	22.4	22.2	NS
	Inflorescences	11.9	10.3	11.3	NS
	Bunches	11.8	10.2	11.2	NS

° For explanation see footnote to Table 1.

Table 3. Average daily increment (cm) of spike leaf of date palms irrigated by one trickler pipe (O), 2 trickler pipes (T), and sprinklers (S), during the months of 1969 and 1970.

Year	1969				1970			
Month	O	T	S	Signifance*	O	T	S	Significance*
JAN.	2.25	2.34	1.91	NS	2.31	2.33	2.38	NS
FEB.	1.97	1.96	1.79	NS	1.70	1.83	1.61	NS
MARCH	2.68	2.86	2.45	NS	2.77	2.52	2.26	OT/S
APRIL	2.77	3.00	2.71	NS	2.96	2.82	2.34	OT/S
MAY	3.51	3.54	3.22	OT/S	3.45	3.14	2.75	O/T/S
JUNE	3.68	3.83	3.37	OT/S	3.62	3.50	3.21	OT/S
JULY	3.80	3.62	3.31	O/T/S	3.57	3.58	3.58	NS
AUG.	3.68	3.27	3.05	O/T/S	3.52	3.48	3.67	NS
SEPT.	3.75	3.59	3.34	NS	4.29	4.11	4.01	NS
OCT.	3.98	3.91	3.82	NS	4.50	4.30	4.26	NS
NOV.	3.45	3.01	2.70	O/S	4.08	3.88	3.92	NS
DEC.	2.95	2.67	2.16	O/S	2.24	1.96	2.07	NS

° For explanation, see footnote to Table 1.

Table 4. Average yield per tree, fruit weight, and percentage of fruit in different grades in trees irrigated by one trickle pipe (O), 2 trickle pipes (T), and sprinklers (S).

Year	Parameter	O	T	S	Significance*
1969	Fruit weight (gr.)	7.1	7.2	6.8	NS
1970	Yield/tree (kg.)	91.5	76.4	68.7	O/TS
	Fruit weight (gr.)	8.8	8.9	7.7	OT/S
	Grade A (%)	73	73	58	OT/S
	Grade B (%)	12	16	25	OT/S
	Dry (%)	10	10	17	OT/S

° For explanation, see footnote to Table 1.

mature date palms under trickle irrigation, a system whereby only a small proportion of the ground is wetted, in comparison with sprinkler irrigation where the whole area between trees is wetted. An experiment of this sort has to extend over a number of years before final conclusions may be drawn. After the first 2 years it may be concluded that there is no difference between wetting a limited area close to the tree and wetting the entire area between trees. The higher yields obtained under trickle irrigation may be due to better exploitation of water under this system, since with sprinkling a greater quantity of water is lost to evaporation before it reaches the trees. The advantage noted for one pipe of tricklers (in comparison with 2) may be explained by the deeper penetration of water from a single pipe. In this garden, deeper penetration of water would dilute the saline ground water, enabling greater absorption by the trees. Another explanation might be that in the case of a single pipe, the volume of soil remaining at a high temperature (not being cooled by the irrigation water) is greater. The higher soil temperatures in this case lead to more vigorous growth. We intend investigating these points further in the coming season by enlarging the total quantity of water given and by concurrent measurement of soil temperature.

ABSTRACT

The objective of this experiment was to determine whether it is possible to grow mature date palms under trickle irrigation, a system whereby only a small proportion of ground is wetted in comparison with sprinkler irrigation where the whole area between trees is wetted. After 2 years, an advantage was found in the trickle-irrigated trees with regard to vegetative growth and yields. The latter was pronounced in the second year and could be explained by the higher weight of individual fruits in these treatments.

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MECHANICAL POLLINATION EXPERIMENTS WITH THE DEGLET NOOR DATE PALM IN 1970

E. G. VIS, R. M. PERKINS and G. K. BROWN[1]

This report discusses the results of the 3rd year's use of ground-level equipment for the pollination of Deglet Noor date palms. The study was conducted by the U.S. Department of Agriculture and the University of California in cooperation with the California Date Growers' Association. It is a continuation of work previously reported (1, 2). Previous work with helicopter pollination methods had appeared promising initially when spring temperatures were above normal but had failed almost completely when spring temperatures were below normal (3). It was necessary to continue the pollination program to establish the consistency of the two ground-level methods.

EXPERIMENTAL APPROACH

The experiments were conducted in a 17-acre garden in La Quinta, California, which had 3 separate blocks of palms classified as: tall (35-45 ft to the bloom area); medium (25-35 ft); and short (5-25 ft). We designated 5 plots of about one acre each in both the tall and the medium blocks and 7 plots in the short block for separate pollination treatments. Two plots in each block were pollinated with the bloom duster. Two plots in each of the tall and medium blocks and 4 plots in the short block were pollinated with the palm duster. One plot in each block was hand pollinated as a check. One half of the bloom duster and palm duster plots were pollinated twice a week and the remaining plots pollinated once a week. Three quarts of pollen per acre were used in all plots except in two palm duster plots in short palms where 1½ quarts (half rate) were used.

The bloom-duster method has a man operating a compressed air bloom duster from a basket on a harvesting tower. The man in the basket directs a puff of dry pollen to each bloom, and he is moved from palm to palm. The work rate of this system is about 1 - 1⅓ acre/hr with a two-man crew.

The trailer-mounted palm duster has a "Roots" type blower that forces air through a pipe to the bloom area of the palms. A pollen-flour mixture is metered into the airstream and is carried to the blooms. The duster operator stands on a platform attached to a fork-lift mast, which moves vertically to adjust the distance between the nozzle outlet and the blooms as the machine moves past the palms. This system requires a tractor driver and a duster operator, who can pollinate about 2½ acres/hr.

The guide for thinning the mechanical pollination plots was from our 1969 results (2). Temperatures during the pollination season were about the same as in 1969; therefore, we assumed fruit set would be about the same with a particular method and frequency. We calculated the percentage of strands to be removed by center thinning, assuming total strand length per bunch would be similar to that found in 1969 and that the average should not exceed 700-800 fruit/bunch on short palms, 1,000 fruit/bunch on medium palms, 1,200-1,300 fruit/bunch for tall palms.

Table 1. Suggested percentages of fruit to be removed per bunch.

Block	Bloom duster		Palm duster		
	2/wk	1/wk	2/wk	1/wk	1/wk (½ rate)
	%	%	%	%	%
Tall	43	21	32	11	—
Medium	52	34	43	25	—
Short	57	40	50	46	28

The percentages in Table 1, based on pollination method and frequency, were suggested as a guide for center thinning of individual bunches. These numbers are the percentage of fruit to be removed from each bunch; however, the crew used these numbers as the percentage of strands to be removed from the bunch.

With these figures as a guide, the crew used their judgement as to how much to remove from each bunch. They were instructed not to thin bunches with light fruit set as heavily as the bunches with more fruit left on the bunch at the time of thinning. Thinning did not commence in the mechanically pollinated plots until the latter part of May at which time June drop had already started. All blooms in the hand-pollinated plots were thinned normally by center cutting and end cutting at the time of pollination.

Either 2 or 4 palms in each mechanically pollinated plot in the tall and short palms were selected for individual bunch records. All the blooms in these palms were tagged and the stage of development of each bloom was recorded once a week during the pollination season. Air temperature was recorded in the bloom area of a palm approximately 20 ft above ground and was assumed to be a representative temperature for the entire garden.

The viability of the pollen that was used in the mechanical pollination plots averaged 82% and ranged from 80 to 85%.

All plots were individually harvested by machine between 17 and 25 November. The following information was tabulated for analysis:

1. Tagged bunches on check palms were harvested individually to determine number of pollinated and unpollinated fruit per bunch and bunch size (inches of strand), from which fruit set was calculated.

2. The total number of palms and bunches in each plot was recorded.

3. The average bunch size for each plot was determined by measuring all bunches on 8 palms in each plot.

The following information for each plot was provided by Cal Date Co. from receiving records: a) percentage unpollinated fruit; b) fruit size; c) fruit quality; d) total yield per plot.

RESULTS

Application schedule. Pollen applications were started on 28 February in the short palms and on 16 March in the tall and medium palms and continued in all blocks through 6 May. The short palms, pollinated twice/week with the palm duster, had the greatest number of applications, 20; and the tall palms because of the shorter blooming period received 14 applications. Short and tall plots on a once/week schedule received 9 and 8 applications, respectively.

It was necessary to irrigate every other border alternately to maintain pollination schedules. Thus pollinating equipment could reach at least one side of the palm at all times and at the same time a satisfactory irrigation schedule could be maintained.

Weather conditions. When the first blooms in the short palms were pollinated

Table 2. Fruit quality for early and late bunch with light to heavy fruit sets.

Block	Fruit/bunch	Date of pollination					
		28 Feb - 31 Mar			1 April - 6 May		
		Marketable	Products	Small	Marketable	Products	Small
	no.	%	%	%	%	%	%
Short palm	up to 799	13	84	3	57	33	10
	800-1199	16	76	8	24	55	20
	1200 & above	3	59	38	35	37	28
	Av.	6	63	29	43	39	17
Tall palm	up to 1299	25	67	8	69	27	4
	1300-1799	40	51	9	50	45	5
	1800 & above	30	46	24	60	16	24
	Av.	34	48	16	58	28	7

[1] E. G. Vis and G. K. Brown are Agricultural Engineers, AERD, ARS, USDA, Riverside, California, and R. M. Perkins is Associate Specialist, Soil Science and Agricultural Engineering Department, University of California, Riverside.

between 28 February and 5 March, the daily maximum temperatures went below 70° F (Fig. 1). During the rest of the season the daily maximum temperature was not below 80° F for more than 3 consecutive days except for the period of 12-22 April when temperatures dropped below 70° F. On 8 of the 20 days when applications were made, the winds were gusty, but not sufficiently strong to keep pollen from reaching the bloom area. On only one day did the winds reach high enough velocities to prevent the pollen mixture from reaching the bloom area.

Thinning results. All plots pollinated by mechanical methods were thinned in the latter part of May by removing strands from the center of the bunch. It was difficult to thin the bunches so late because the strands of the bunches became tangled in the fronds and were nearly out of reach of the workers.

Using the suggested thinning schedule, the crew appeared to use good judgement in determining relative bunch sizes. Measurements of the harvested bunches showed that the average bunch size (inches of strand) was larger in the once/week plot than in the twice/week plots. Bunch sizes ranged from 686 inches of strand in the hand-pollinated plots to the largest bunches of 841 inches of strand in the palm duster once/week plots. The relative size of the bunches was as expected; however, a number of bunches in all the plots had too many fruit, a condition which contributed to poor fruit quality. For example, in the tall block 34% of the mechanically pollinated bunches and 26% of the hand-pollinated bunches had 1,800 or more fruit compared with the suggested number of 1,200 fruit per bunch. The highest percentage of marketable fruit was 40% in the mechanically pollinated plots and 38% in the hand-pollinated plots. Fruit quality was also poor this year in many hand-pollinated gardens located in the southern end of the valley. This makes it difficult to determine whether fruit quality can be maintained by only center thinning. When we mention good quality fruit in this paper, we are referring to the natural, waxy, and No. 1 dry fruit which normally are classified as marketable grades of fruit. "Poor quality" refers to small fruit (less than 6.5 gram) and dry fruit classified as culls. We are not referring to poor quality due to mite damage, insect infestation and dirt.

An analysis of the fruit quality from individual bunches on 4 tall palms and 8 short palms (Table 2) showed that, as the number of fruit per bunch increased, the percentage of small fruit (fruit weighing less than 6.5 gram) also increased.

Fruit set on checked palms. Using information from check palms, we could compare fruit set for bunches pollinated during periods of different temperature conditions and by different systems (Table 3). Low temperature conditions existed between 28 February and 5 March when maximum temperatures dipped below 70° F, and from 12-22 April maximum temperatures were below 80° F most of the time. There was a fruit set reduction of 10-33% on bunches pollinated during the periods of low daily maximum temperatures (Table 4).

The twice/week schedule resulted in better average fruit set than the once/week schedule for both mechanical methods. However, under any combination of machine systems and the temperature conditions above, with this range of fruit sets, an adequate number of fruit per bunch was

Table 3. Average fruit set in each plot[1], La Quinta, 1970 and 1969.

Bloom	Plot[2]	Pollination method & frequency	Average fruit set (Fruit/Inch) 1970	1969
	no.		fruit	fruit
	3	Hand	2.21	1.98
	2	Bloom 1/wk	2.15	1.97
Tall palm	4	Palm 2/wk	1.92	1.92
	5	Palm 1/wk	1.90	1.84
	1	Bloom 2/wk	1.87	2.16
	10	Bloom 1/wk	2.34	2.07
	9	Bloom 2/wk	2.20	2.40
Medium palm	7	Palm 2/wk	2.13	—
	8	Hand	2.02	1.73
	6	Palm 1/wk	1.92	1.18
	11	Hand	2.03	1.39
	14	Bloom 2/wk	1.91	—
	18	Palm 2/wk	1.77	1.54
Short palm	13	Bloom 1/wk	1.57	—
	17	Palm 1/wk	1.57	1.68
	16	Palm 1/wk[3]	1.36	—
	15	Palm 1/wk[3]	1.25	—

[1] All bunches were center thinned in the mechanically pollinated plots in 1970 and not thinned at all in 1969.

[2] Plot numbers refer to 1970 experiments.

[3] Two plots that received 1½ quarts of pollen per acre per season. All other mechanically pollinated plots received 3 quarts.

Table 4. Average fruit set on checked bunches during periods of high and low temperatures. Footnotes indicate bunches that were pollinated during periods of low daily, maximum temperatures.

	Tall Palms		Short Palms	
	1/wk	2/wk	1/wk	2/wk
	fruit/inch	fruit/inch	fruit/inch	fruit/inch
Palm duster	1.9	2.1	1.9	2.0
3 quarts	1.7[1]	—	—	1.5[2]
Palm duster	—	—	1.8	—
1½ quarts	—	—	1.2[1]	—

[1] 12-22 April, temperature fluctuated between 68-84° F.

[2] 28 February - 5 March, temperature fluctuated between 67-81° F.

Table 5. Theoretical yield[1], La Quinta, 1970 and 1969.

Block	Plot[2]	Pollination method & frequency	Bunch size 1970	1969	Theoretical yield 1970	1969
	no.		inches		lb/palm	
	2	Bloom 1/wk	773	807	381	412
	1	Bloom 2/wk	773	807	336	394
Tall palm	5	Palm 1/wk	773	807	352	380
	4	Palm 2/wk	773	807	355	383
	3	Hand (15.8 bunches)	687	685	369	357
	10	Bloom 1/wk	733	834	373	348
	9	Bloom 2/wk	733	834	350	382
Medium palm	6	Palm 1/wk	733	834	279	235
	7	Palm 2/wk	733	834	315	—
	8	Hand (13.9)	643	709	283	261
	11	Hand (11.8)	592	—	206	—
	14	Bloom 2/wk	548	—	187	—
	13	Bloom 1/wk	589	—	165	—
Short palm	18	Palm 2/wk	548	765	157	147
	17	Palm 1/wk	589	773	154	233
	16	Palm 1/wk[3]	589	—	141	—
	15	Palm 1/wk[3]	548	—	117	—

[1] Determined by multiplying the bunch size shown by the number of bunches per palm shown for the hand-pollinated plot and the average number of fruit per inch, then dividing by the number of fruit per pound to obtain yield.

[2] Plot numbers refer to 1970 experiments.

[3] Two plots that received 1½ quarts of pollen per acre per season. All other mechanically pollinated plots received 3 quarts.

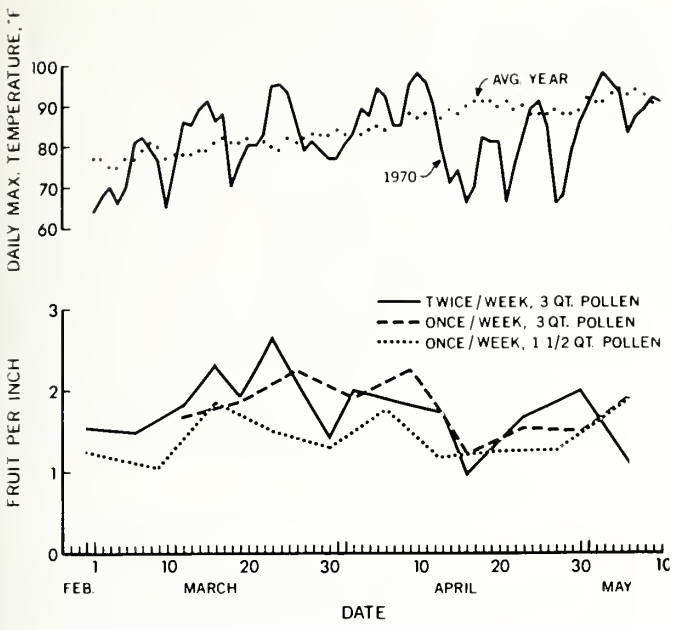

Fig. 1. The daily maximum temperatures for 1970 and an average year based on 60 years of records for Indio are shown at the top. Fruit set in number of fruit per inch of strand is plotted above the first day on which the bloom was pollinated.

achieved so that the average yield was equal to that normally obtained with hand pollination in this garden.

Fruit sets were of the same magnitude as recorded last year (2). The range of fruit set for individual bunches is shown in Fig. 1 for two rates of application and the once/week and twice/week application schedules for the palm duster in short palms.

The average fruit sets with the palm duster in short palms and the temperature profile are plotted in Fig. 1. Blooms that were pollinated during the two cool periods had lower fruit sets than blooms that came out during periods when higher temperatures occurred. The fruit set with once/week schedule and 1½ quarts of pollen per acre was consistently lower than that of blooms that received 3 quarts of pollen. The fruit sets in the remaining plots were similar to those obtained last year and do not appear in this report.

Average fruit set. The average bunch size and the average fruit size in each plot were used to calculate an average fruit/inch for the entire plot (Table 3). Average fruit set in the plots, excluding the ½ rate plots, ranged from 1.57 to 2.34 fruit/inch. No method was consistently better in all plots. However, in the range of fruit sets listed above there are enough to maintain 1,200 fruit per bunch on tall palms and 800 fruit per bunch on short palms. These numbers of fruit are the maximum that we estimated should remain on bunches in this garden to get good quality fruit.

The two plots pollinated once/week with 1½ quarts of pollen had 1.36 and 1.25 fruit/inch, which would be just enough fruit per bunch without any thinning. However, we feel that if there had been cooler temperatures, the fruit set would have been less; consequently, the yields would not have been as great even without thinning.

Theoretical yield. The comparison of actual yields did not indicate a true difference between plots because the average number of bunches per palm and average bunch size in each plot were different. We calculated a theoretical yield for each plot (Table 5) by assuming: 1) the average number of bunches per palm was equal to that for hand pollination in that block; 2) bunch size was equal to that of the average of all bunches for all mechanical plots in each block; 3) the fruit size was the same as indicated on the receiving record; 4) the fruit/inch was as shown in Table 4.

Theoretical yields of pollinated fruit in the mechanically pollinated plots ranged from 9% lower to 32% greater than in the hand plots in the tall and medium palms. Yields in these blocks were also consistent with 1969 yields. Yields of the mechanically pollinated short palms were consistently lower than in the hand plot. The lower yields were caused by the short palms producing more early blooms that were pollinated during the period of low temperature during late February and early March.

Fruit quality and grower return. In the tall and medium palms, marketable grade ranged from 18-40% and culls 17-36%. In the short palms, marketable ranged from 0-18% and culls 14-39%. In all plots there were many small-dry fruit which were classified as culls. The poor quality of fruit this year was thought by growers to be caused by adverse climatic conditions (winds

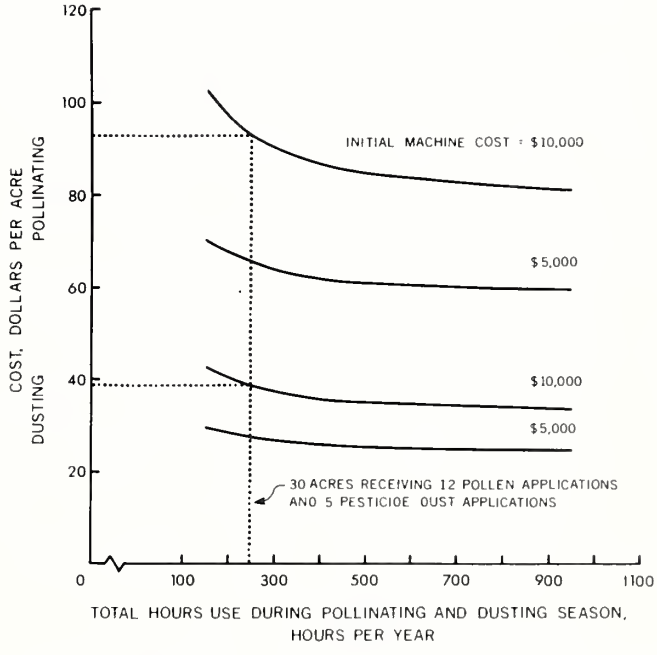

Fig. 2. Operating cost of palm duster versus annual hourly use. The following assumptions were used in the analysis:

1. **Total machine life — 3000 hours**
2. **Salvage value at end of 3000 hour life — 10% of initial cost**
3. **Interest, taxes, insurance — 12% per annum on the average value of machine**
4. **Repairs — 100% of initial cost during life of machine**
5. **Fuel and oil — $0.43/hour**
6. **Wages — 2 men at $3.00/hour = $6.00/hour**

and high temperatures during September), although these conditions and their effect on fruit quality have not been documented. An excessive number of fruit/bunch contributed to poor quality fruit on many bunches in our plots.

In Table 2, it is evident that as the number of fruit per bunch increases, the percentage of small fruit also increases. Also, bunches that came out during the first ½ of the pollination season had a greater percentage of small fruit and less marketable. At 10 cents/pound for marketable fruit, 6 cents/pound for products, and 0.0 for culls, fruit on early bunches from tall palms was valued at 6.30 cents/pound and late bunches at 7.48 cents/pound. Fruit from short palms was valued at 4.38 cents/pound for early bunches and 6.64 cents/pound for late bunches. Using a twice-over harvest may help to increase the number of marketable fruit harvested from some gardens.

Pollination cost with the palm duster. The cost per acre for pollinating with the palm duster was calculated. The cost curves and assumptions to arrive at the cost are shown in Fig. 2. The initial value was assumed to be $10,000 for a trailer-mounted unit and $5,000 for a tractor-mounted unit. Cost curves are also shown for applying pesticides since the same basic machine can be used for both functions.

An example to explain how the curves can be used is given:

a. 250 hours per season would amount to pollinating 30 acres 12 times/season (twice week/schedule) and dusting the same acreage 5 times.

b. Corresponding cost is about $93/acre for pollinating and $39/acre for dusting if the initial machine cost is $10,000.

c. With a $5,000 initial machine cost and same acreage, the cost would be about $66 for pollinating and $27 for dusting.

d. Using the machine a greater number of hours per season decreases the cost per acre.

e. The maximum number of acres that can be pollinated with this machine is about 60, applying pollen once/week to the entire acreage at a work rate of 2 acres/hour in a 30-hour effective work week.

To the above cost must be added cost of operating the tractor and cost of pollen. With these costs it appears that mechanical pollination will not decrease the cost of pollination, but will enable the industry to pollinate the same acreage with less manpower.

CONCLUSIONS

1. The daily maximum temperatures were favorable for good fruit set during most of the season.
2. Both mechanical pollination methods, applying 3 quarts of pollen per acre in the season, gave fruit set similar to that for hand pollination.
3. The palm duster application of 1½ quarts of pollen per acre in the season resulted in 13-20% reduction in fruit set when compared with applying 3 quarts of pollen.
4. There was a 10-35% reduction in fruit set on bunches that were pollinated during the two cool periods.
5. Fruit quality was generally poor because 26-34% of the bunches were not thinned enough, and adverse climatic conditions also contributed to the development of small-dry fruit.
6. Fruit quality was related to the age of the bunch. Older bunches had more small fruit than the later bunches.
7. The theoretical yields for the tall and medium palms in the mechanical plots were similar to yields in hand plots and similar to last year's results.
8. Pollinating cost with the palm duster probably will not decrease the cost of pollination, but will enable the industry to pollinate the same acreage with less manpower.

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COMPARISON OF HEAT AT INDIO, CALIFORNIA WITH THAT AT BISKRA AND TOUGGOURT, ALGERIA AND ITS EFFECT ON DEGLET NOOR DATE QUALITY

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The Deglet Noor date originated in the vicinity of Touggourt, Algeria, early in the 17th century (7). This variety is, therefore, about 350 years old. It has been an important variety in date-growing oases of the Sahara Desert in Algeria and Tunisia during much of the subsequent time, and in the United States beginning soon after its introduction in 1900 (2, 7). The wisdom of the selection of this variety is demonstrated by the fact that it has withstood the competition of other varieties since its original selection.

The fine quality of fruit produced in Biskra and Tolga, Algeria, under favorable soil and cultural conditions shows that it is well adapted to the prevailing climate of those areas. Growers and packers in those areas admit that the quality of Deglet Noor dates grown in parts of Tunisia is equally good, and claim that the quality of these dates is better than that of the same variety grown in other parts of these two countries, including Touggourt. Assuming that this evaluation is correct, this variety is even better adapted to the Biskra and Tolga areas than to Touggourt, where it originated.

Experience by American date growers suggests that the Deglet Noor, although by far the most important variety grown in the United States, is sensitive to injury from the high temperatures that occur some years during part of the growing season. Unusually high temperatures from about mid-April to the end of May seem to be particularly harmful (5, 6). Unusually high temperatures in the fall, just before harvest, are thought by some to be injurious, but the relationship here is not consistent. Temperatures in June, July, and August are considerably higher than those earlier and later, but there is no evidence that heat in these midsummer months is harmful.

Dry-textured dates produced in the Coachella Valley in years with unusually high April-May temperatures are likely to be more acidic than dates produced in years with lower temperatures in April and May, but which may be dry from delayed picking or from other causes. The more acidic dry-textured dates are more difficult to hydrate and soften into an acceptable texture than are the less acidic ones produced under more favorable temperatures (4).

Observations suggest that Deglet Noor fruit in Algeria tends to have a more desirable texture, retains a lighter color, even after processing and storage, and is more easily hydrated than fruit of the same variety grown in the Coachella Valley. Dates grown in the vicinity of Biskra and Tolga have qualities attained in the Coachella Valley only in the more favorable years.

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[1] Pomona, California; formerly Investigations Leader, U.S. Dept. Agr., Pomona, Calif. These observations were made while I was serving as a consultant in Algeria for General Electric TEMPO, Santa Barbara, Calif., 26 October to 7 November, 1970. The visit was limited to the region around Biskra.

Dates grown near Tolga or Biskra, and near Indio in 1968 were processed in Marseilles, France, under supposedly identical conditions and stored together under refrigeration until the fall of 1970. I observed these dates in Algiers in October 1970. The Algerian dates were still attractively light in color and had excellent texture, whereas those from Indio were very dark in color although the texture and apparent moisture content as indicated by the consistency were similar to those of the Algerian dates. This difference in behavior suggests an inherent difference in the dates grown in these two widely separated areas.

Several environmental factors such as soil characteristics, water quality, cultural practices, and atmospheric temperatures might contribute to the development of the different characteristics of the dates in these two areas. The possible effect of excessively high temperatures in April and May will be discussed in this report.

Here are the mean monthly maximum temperatures in degrees F at Indio and Biskra, as provided by the Pomona, Calif., office of the National Weather service, and at Touggourt, as reported by Lasserre (1) and as quoted by Nixon (3). Annual mean maximum temperatures and years of record are included.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	Yrs
Indio	70	74	80	87	93	102	107	105	102	92	81	72	89	55
Biskra	61	65	71	79	87	97	107	105	94	82	70	62	81	27
Touggourt	63	67	73	82	90	99	106	104	97	84	71	63	83	15

Maximum temperatures at Indio are higher than those at Biskra and Touggourt except in July and August, the two warmest months, when all stations are similar. In the most critical months the mean maxima at Indio are 6 to 8 degrees higher than those at Biskra, and 3 to 5 degrees higher than those at Touggourt. These differences in maximum temperatures are suffieient to produce the observed differences in the quality of the dates grown at Indio and at Biskra, and also at Touggourt if the evaluation of the dates from this area is correct.

If the suspected effect of high temperatures in September is valid, the higher temperatures at Indio in this month might be responsible for some of the observed differenees in date quality.

Temperatures at Indio are such that serious injury to the dates is inflicted only in seasons when the mean maximum temperatures in the April-May period are above normal. The texture is likely to be fairly good in years when this mean is elose to normal, but it is likely to be at its finest in years in which this temperature is somewhat below normal.

Although the mean annual maximum temperature at Biskra (81° F) is considerably below that at Indio (89° F), the total season's heat units are sufficient to permit the dates to develop excellent quality. This does not hold, however, as one moves northward into the canyons that extend into the Sahara Atlas range, where the temperature is too low for Deglet Noor production.

Since the Deglet Noor variety is so well adapted to temperatures customarily experienced in its native home, one might expect that a variety equally well adapted to temperatures that prevail in the Coachella Valley could be developed by an appropriate breeding program. Breeding stock for such a program already exists at the U.S. Date and Citrus Station at Indio. Conceivably several generations of date palms and much field testing will be required before a variety with the desired characteristics is produced, but efforts in this direction seem in order if the American date industry is to prosper.

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REMINISCENCES OF EARLY DATE GROWING IN CALIFORNIA

PAUL POPENOE[1]

My initial contact with date growing in California began in 1911 when I received, in Naples, Italy, a mysterious cablegram. I had made a six months trip through Europe (on a budget of $2 a day), had arrived at the end and bought my ticket to return home by steamer, when this message came to me: "Will meet you Hotel Victoria, Valencia, Spain, December 28." It was signed with a name I had never heard: "Walter T. Swingle". "Who is he and what's he got on me?", I said to myself.

Before the day was over, a letter from home cleared up the mystery. My father, F. O. Popenoe of Altadena, owned a nursery which specialized in subtropical fruits (he introduced the Fuerte avocado.) A woman who had bought some land in Coachella Valley told him she would buy 1,000 Deglet Noor offshoots if she knew how to get them. He informed her that he had a son in the Mediterranean at the time, who could easily go to Algeria; and the Bureau of Plant Industry asked Dr. Swingle, just then in the same part of the world, to get in touch with me.

I spent a couple of weeks in Spain with Dr. Swingle, who was studying the horticulture there in company with Dr. Louis Trabut, famous Algerian botanist, and M. Brunel, the director of agriculture. We visited Elche, famous for its cultivation of date palms; then I headed for Algeria, taking with me a little phrase book of the Arabic language from Dr. Swingle. I studied both that language and the cultivation of dates diligently, then returned to California with the offshoots. Meanwhile my father had found an eager and widespread interest in date growing in California and, like many others, thought it had an unlimited future. Even then we were getting the same scare stories that we are getting today — the world would starve to death because it could not produce enough food to support its rapidly growing population. The palm not only produced per acre a large amount of fruit of high food value, but would produce on land not suited to many other types of cultivation. He got contracts from a number of persons to buy offshoots and also bought some land on his own account for that purpose — a fine tract near Thermal. His nursery in Altadena was named the West India Gardens, and he organized a corporation for the new venture, to which he gave the name of the West India Plantations. Three months after my return he was prepared to send me and my younger brother Wilson, an avid horticulturist, out for more offshoots.

Where would they be found? It was hard to get any large quantity of Deglet Noor offshoots in Algeria. Beyond this, the Arab world, to which the date palm belonged, did not even consider North Africa to be a part of it — nobody ever heard of their dates! The best dates were thought to be grown in Arabia itself, but the great commercial production which supplied the rest of the world was in the countries at the head of the Persian Gulf, then part of Turkey, now Iraq. Dr. David Fairchild of the U.S. Bureau of Plant Industry had visited it in 1902 and sent in a few offshoots of some of the good varieties, so we started for that region in June of 1912.

The variety best known commercially in the U.S. at that time was not from the upper region, however, but from a small valley in the Kingdom of Oman on the eastern coast of the Persian gulf. This was the Fard, a smallish black date of rather mediocre quality but able to keep its shape when shipped and therefore more popular than the Halawis which were beginning to appear from Basrah under the name of Golden Date, but which were pressed into a mass of stickyness. Since the Fard was the only date which most Americans had ever tasted or even seen, it seemed at the time a good idea to get a few of the offshoots, and the American consul in Masqat arranged with the sultan to give us his own camels and bodyguard for the 60-mile ride into the interior. The cultivation of the palm in that remote area is at a higher level of efficiency than in any other area outside of the U.S. of which I have ever heard, but the offshoots we brought to Coachella were, one might say, never again heard of.

To the north of Oman was a desert area called Hasa, which in Arab opinion produced the world's finest dates, first place being given to one called Khalaseh or "quintessence." Obviously we ought to get some of those, but the Turkish government wisely refused to give us a permit to enter, frankly stating that it could not guarantee our safety (we had already been under fire twice, in Oman, from rebellious tribesmen.) I did succeed, via an American missionary in the island of Bahrein, to get a man sent in to Hofhuf, capital of Hasa, and he brought out 400 offshoots, only a few camel loads being stolen on the way to the coast. It is, of course, now well known in Coachella, although Col. Dale Bumstead of Phoenix became so enamored of it that he bought up a large part of the palms to take to Arizona.

At Basrah, the port from which Sinbad the Sailor always set sail on his hair-raising adventures, we entered the world's greatest date-growing country. The two varieties which competed as best, in the popularity polls, were Barhi and Awaydi, both very scarce; we got enough offshoots of the former to give it a good start in Coachella and it is now on the market as the world's finest — a matter of taste! But the standard variety there was Khadhrawi, the one that the best families would invariably serve to their guests, and we therefore got a quantity of these together with Halawis.

After making arrangements there we went up the Tigris and Euphrates rivers to Baghdad, which had the reputation in the Muslim world of producing better dates than Basrah, although not so many. Here the choice was Khustawi but the money-maker was Zahidi, because of its heavy production, early ripening, and unmatched shipping characteristics. It was sent all over the Orient. We got a good quantity of all these offshoots, as well as Maktum, a very highly esteemed Baghdad variety which had already given a good account of itself in the U.S. Returning to Basrah, we packed our purchases there, loaded them on a little freight steamer bound for London, 9,000 offshoots altogether, but dropped off in Algeria to get 6,000 more Deglet Noor offshoots, the most that the government would allow us, since the French colonists were increasing their protests against American competition. All reached California in good shape and were distributed among growers in the Coachella and Imperial valleys, with a good part reserved for the West India Plantations.

I have named the standard varieties that made up the bulk of our shipment, totaling 15,000 offshoots; but we had a few of several dozen other varieties chosen for experimental purposes. A few date palms had been grown in the San Joaquin and Sacramento valleys, half a century earlier; the palms grew well but fruit did not mature satisfactorily. It seemed likely that varieties which ripened their fruit in a very short season might be the foundation of extensive plantings in that great inland area, so we saw the possibility of wide sales of offshoots there for dooryard planting, even if the fruit were not equal on the market to other varieties. This venture never panned out, however, partly because of the government's growing alarm over the spread of Marlatt and Parlatoria scale insects. Imports already required sterilization, but the U.S.D.A. now clamped the lid down, prohibiting the further shipment of offshoots from abroad except by its own staff for research or experimental purposes.

My father visioned a wide spread of date growing, as I noted above; I had spent much time studying every aspect of it, and as soon as I returned to Altadena I went to work under high pressure on a book intended to popularize the subject. The West India Gardens itself published it, in 1913, under the title, "Date Growing in the Old and New Worlds." One thousand copies were put in circulation. Although an immense amount of work has been done since then, it is pretty accurate to say that no equally general and comprehensive treatise has been issued. Twenty years later I myself wrote a much bigger and better one — so extensive that I never could find a publisher for it!

Even before we returned from this trip, my brother Wilson and I both had jobs. David Fairchild, chief of the Bureau of Plant Introduction of the USDA, was an old family friend. He wanted plant explorers and had contracted, so to speak, for Wilson. At the same time he had had unloaded on his shoulders an organization, the American Breeders Association, which was devoted to spreading the new science of genetics — plant and animal breeding and, in a sense, human breeding in the form of eugenics. He needed someone to take this over and tapped me. We reorganized it under the name of American Genetics Association and turned the quarterly into a new monthly Journal of Heredity, — both "still going strong." Dr. Swingle asked me to join his staff; if I had done so, I might never have done anything but date growing; but I was already committed to Dr. Fairchild in Washington.

Meanwhile the West India Plantations were letting the palms grow. As everyone hereabouts knows, it takes a bit of time for a date plantation to become profitable. My father had at the West India Gardens a real prize winner in the Fuerte avoeado,

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which almost immediately became recognized as foremost in its field, and is so to this day — more than half of all the avocados grown commercially in the entire world are Fuertes. In Australia, Southern Spain, Israel, South Africa, — anywhere you go in avocado territory you will find them in the market. Naturally he wanted to take advantage of this popularity so staked everything on a great planting of budded seedlings; the almost unparalleled heavy freeze of 1913 killed it all and left the West India Gardens and its offshoot, the West India Plantations at Thermal, in a precarious condition financially. He therefore sold a controlling interest to three Minnesota investors, who had no real interest in it but were looking merely for a chance to make money.

Meanwhile in Washington, with the help of some of the nation's top scientists, I had developed the Journal of Heredity into a position of international recognition. Then came World War I. At the outset, America faced an extraordinary danger, as serious as it was not-talked-about, namely, that every European nation in the war had more soldiers disabled and in hospital with venereal diseases than with battle wounds. We were not willing to make war on those terms, so a very broad scale program was developed to prevent venereal diseases with medicine, law enforcement, and education. No nation had ever known anything like it. One of the leaders was Dr. (then Colonel) William F. Snow, whom I had first known as a Stanford student when he was health officer there. He had then gone to New York City as head of an organization set up by Pres. Charles W. Eliot of Harvard and others to combat venereal disease, particularly by the reduction of commercial prostitution, which was, in war and peace, the main source. John D. Rockefeller, Jr. gave Dr. Snow over a million dollars to meet expenses which could not easily be met from War Department funds, and Congress passed some very stiff legislation. I was picked up in the first draft and Col. Snow asked to have me transferred to his organization — at that time it could be done. My job was to stir up the local authorities throughout the Southwest to enforce the acts of Congress prohibiting prostitution. Later I was taken to Washington and made director of that section of the Army! At the end of the war, when I was separated, I felt we had made such valuable progress that I wanted to help keep it going, so I went to New York as executive secretary of Dr. Snow's "outfit", the American Social Hygiene Association (now the American Social Health Association).

There was a young man on the staff who had in some way gotten over into its educational activities from the bank with which he had been associated. His father, Andrew Russel, was an Illinois banker and politician, long time Auditor of Public Accounts in the state. Robbins Russel did not like city life, nor did I, and I used to talk to him about how much I would enjoy getting back to Coachella Valley and growing dates. He became enthused with the idea and suggested that he might be able to get his father to buy the Tropical Date Company, as the old West India Plantations had been renamed. His father made a trip to the valley and looked it over thoroughly, liked the prospects, and paid the Minnesota owners $95,000 for their controlling interest. He gave me a contract as joint manager with his son Robbins. I was married on Aug. 23, 1920, in New York City and that same evening my wife and I took the train for California.

We settled comfortably at the Tropical Date Company and I felt a great satisfaction in being among the palms which I had brought across the ocean; in remembering the many thrilling experiences they represented; in getting them properly labeled and flourishing. After a year Andrew Russel came out again; he wanted to have the entire control in his own family, so bought out my contract, and a little later the one-time West India Plantations, later Tropical Date Company, became Russel Brothers.

I had no intention of giving up date growing, which attracted me so strongly, so looked around for a place of my own. The American Fruit Growers about that time had started a project of owning land which they would lease to someone who would grow produce for them to sell, and they had purchased a choice piece of property, 80 acres, on the highway facing the date packing house at Coachella. Their own-and-lease idea had not worked out satisfactorily and they wanted no more of it, so they were happy to have me take this piece off their hands. Part of the recompense Andrew Russel had given me for relinquishing my contract was the right to a good number of offshoots. I picked and removed these to my new place and built a house on the land. I grew cotton when it sold for 50c a pound. When the price dropped to 30c, I was so disgusted that I gave it up entirely and substituted onions and various things — everyone who has owned land for any length of time in the valley knows the story!

In 1925 I had a visit from a Pasadena philanthropist, E. S. Gosney of Pasadena, whom I had long known. He had made a fortune largely through sheep ranches in Northern Arizona, knew that it could not be done if the rancher bred his scrubs rather than his best stock, and believed that the same principle applied to the human race. California had, nearly 20 years previously, adopted a law under which certain of the persons legally committed to the state institutions as "insane" or "feeble-minded" could be sterilized by an operation which would prevent reproduction without any other change whatsoever; other states were doing the same; he thought if we followed up the California cases (then 6,000) and reported on how they had turned out, other states would want to follow, and he asked me if I would help him get this project, which he incorporated as the Human Betterment Foundation, started. I agreed. He then asked if I would not stay in Pasadena and run it. Again I agreed, and for 8 years I ran the Coachella ranch with hired help, coming down for a long weekend twice a month. With Mr. Gosney's support I started the American Institute of Family Relations in 1930, to promote successful marriage and family life. Finally it became evident that I was not going to be able to come back to Coachella Valley as a permanent resident and, with a great deal of regret, I quit. But my heart is still here.

EARLY HISTORY OF THE DATE INDUSTRY IN THE UNITED STATES

ROY W. NIXON[1]

The purpose of this paper is to outline the history of the date industry in the United States to World War II. Much of the early part of the story has been extracted from government bulletins long out of print. Details of developments in Coachella Valley up to 1924 were found principally in the files of the Indio Date Palm, which began publication in 1912. Interviews with pioneer date growers have been a source of some supplementary information. Beginning in 1924 the Reports of the Annual Date Growers' Institute provide a record of activities within the date industry.

EARLY PLANTINGS OF DATE SEEDS IN THE UNITED STATES

The first date palms in the United States were grown from seeds probably planted by missionaries of the Franciscan and Jesuit orders. Although it is possible that date seeds were planted first around the missions of early Spanish Florida, apparently no such plantings survived the climatic and early political vicissitudes of that section. On the other hand, in southern California at some of the missions, whose founding began at San Diego in 1769, a few of the original palms remained until after World War II. Although these old palms were rather striking landmarks, their fruit never attracted much attention. In the damp coastal climate fruit seldom reaches maturity (12); and even when it matures, its quality is usually poor. Early publicity (1) was given to palms grown from seeds planted in many places in Florida soon after it was acquired from Spain. Before the climatic requirements of date culture were known, some hoped to establish an industry there.

In the settlement of the West and Southwest after the Mexican War and the California gold rush, many date seeds were planted. One of the first demonstrations of fruit production from these later seedling plantings was at Winters, Calif., in the Sacramento Valley, where several palms grown from seeds planted by J. R. Wolfskill in 1857 began to bear edible fruit in 1877 (19). Date seeds planted at Yuma, Ariz., during the Civil War produced palms that were fruiting in the early eighties (33). As other scattered seedling palms began to come into bearing during the next two decades, attention was directed to the possibilities for date culture in the warm interior valleys of southern California and Arizona, and before the end of the century there was some interest in the development of commercial plantings.

VARIABILITY OF SEEDLING DATES

Although planting date seeds is often the easiest way of testing the possibilities of date culture in new sections or of getting a few palms that may provide fruit for home use in a marginal climate, the many early attempts to establish commercial plantings in this way were nearly all failures. In any large group of seedlings only about half of the palms are female and produce fruit. The fruit of a seedling is seldom as good as that of the female parent and there is variation from palm to palm. In the few seedling plantings that survived for a while, offshoots from the very few palms producing satisfactory fruit were propagated and thus some new varieties originated. Most of these new varieties in Arizona and California gradually disappeared as offshoots from imported varieties became available. Only a very few are found today, and they are only of local importance because it takes so long to propagate enough offshoots for commercial planting and to demonstrate the superiority of a new variety over those already established.

EXPERIMENTAL IMPORTATIONS OF OFFSHOOTS

As early as 1818 Mitchill (13) suggested the desirability of establishing date culture in the United States and referred to a few specimens of date palms imported from the Persian Gulf. He gave credit for the importation to Henry Austin, an importer of date fruit. The fate of these offshoots is unknown.

About 1876 Charles P. Stone, then attached to the general staff of the Egyptian Army, sent a few small offshoots of Egyptian varieties to southern California where, according to Swingle (29), "These lived and grew, but unfortunately were afterwards allowed to die through the neglect of the property owners."

In 1888 Reasoner (24), writing about the date palm in Florida, stated that "2 or 3 importations of named trees" had been made, but there are no further records.

So far as known, date offshoots from which any palms survived were first imported in 1890 by the Division of Pomology, United States Department of Agriculture, under the direction of H. E. Van Deman. Through arrangements by correspondence with United States consular officials, 9 rooted offshoots in tubs were imported from Algeria and 59 from Egypt. The following year 6 more were obtained from Masqat, Arabia. These plants, which were distributed to various points in New Mexico, Arizona and California, suffered many misfortunes. Their early history was recorded by Toumey (34). Some survived until after World War II, but all have since been removed for subdivisions. Unfortunately, although supposed to be offshoots of desirable varieties, most, if not all, were probably inferior seedlings. They were named, but when they flowered, about half of them proved to be males and the others bore very inferior fruit. However, the successful fruiting in southern Arizona not only of these imported palms but of many seedlings led J. W. Toumey, of the Arizona Agricultural Experiment Station, to urge the United States Department of Agriculture to make another effort to obtain offshoots of choice varieties from the Old World.

The first successful importation of standard varieties true to name was made from Algeria in 1900 under the personal supervision of Walter T. Swingle of the United States Department of Agriculture. A half-dozen specimens had been sent the year before but because of faulty handling after shipment none survived (32). Most of the 405 offshoots in the 1900 importation were of the Deglet Noor and Rhars varieties and were planted near Tempe, Arizona, in cooperation with the Arizona Agricultural Experiment Station.

Several importations of date offshoots were made by the United States Department of Agriculture during the next few years. The more important were those by Fairchild (8) in 1901-2 from Iraq, Baluchistan, and Egypt and by Kearney (11) in 1905 from Algeria and Tunisia. From time to time small lots were obtained through various correspondents.

In 1927 Swingle (31) was invited to accompany a French Government commission to study the dread bayoud disease, which was threatening to destroy the date industry in Morocco. While there he obtained 11 offshoots of the Medjool variety from a disease-free garden at Bou Denib. After fumigation in Washington the offshoots were planted by Frank A. Thackery, field supervisor under Swingle, on an Indian reservation in southern Nevada about 25 miles above Needles, Calif. (33). After several inspections had shown the young palms to be free from any disease or insect pest, they were transplanted in 1935 to the U. S. Department of Agriculture experiment station at Indio. The larger offshoots produced by the young palms were removed at that time, making with the original ones a total of 73 in the Indio planting. Beginning in 1944, offshoots from the Indio planting were distributed to date growers in southern California and Arizona, and the Medjool was soon recognized as a promising new commercial variety.

The last of the experimental importations of offshoots was the one I made from Iraq in 1929. In it were several new varieties, including the much eulogized Amir Hajj. Most of these offshoots were planted in cooperation with the Texas Agricultural Experiment Station at Substation No. 15, Weslaco. The U. S. Department of Agriculture introductions since 1890 have totaled 1,076 lots, comprising more than 20,000 offshoots (35).

COMMERCIAL IMPORTATIONS OF OFFSHOOTS

The fruiting of palms from the early experimental importations by the U. S. Department of Agriculture increased interest in commercial planting of dates and stimulated a demand for more offshoots than were available.

The first date grower who without Government connections went abroad and obtained offshoots for commercial planting was Bernard G. Johnson (16). In September 1903 Johnson returned from Algeria with 129 offshoots, which were planted on land he had acquired near Mecca, Calif. About two-thirds of these offshoots were of the Deglet Noor variety and the others were mostly Rhars and Areshty. Some of the palms in this planting, which was enlarged by later importations, still survive in 1971. In 1908 Johnson made a second trip to Algeria and brought back a small importation of offshoots, some of which were turned over to the newly-established branch of the

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Table 1. Principal commercial importations of date offshoots into the United States.

Date	Approximate number of offshoots	Country of origin	Principal varieties represented	Imported for —	Supervised by —
June 1911	1,100	Algeria	Deglet Noor and Rhars	American Date Co.	H. F. Cole
May 1912	1,000	do	Deglet Noor	West India Gardens	Paul Popenoe
Do	1,000	do	do	American Date Co.	H. F. Cole
June 1912	3,000	do	do	B. G. Johnson	B. G. Johnson
	6,000	do	do		
July 1913	9,000	Iraq	Halawy, Khadrawy, Kustawy, Zahidi	West India Gardens	Paul Popenoe
August 1913	2,000	Algeria	Deglet Noor	Coachella Valley Date Growers Association	B. G. Johnson
Do	1,000	do	do	American Date Co.	H. F. Cole
May-June 1914	5,170	do	do	Coachella Valley Date Growers Association	B. G. Johnson
July 1915	3,000	do	do	do	Do
June 1920	2,000	Egypt	Saidy	Gillette-Rosenberger Date Gardens and Calizona Date Nurseries	S. C. Mason
August 1921	1,400	Algeria	Deglet Noor	do	Do
Do	500	Egypt	Hayany	Phoenix Date Co.	Do
July 1922	7,150	do	Saidy	Gillette-Rosenberger Date Gardens and Calizona Date Nurseries	Do

Arizona Agricultural Experiment Station at Yuma (2). In 1912, with money recently inherited from relatives in Germany, Johnson obtained 3000 Deglet Noor offshoots in Algeria which he first brought to Coachella Valley, but finding few ready buyers, shipped them to Yuma, Arizona, and planted them on land he had acquired there. Beginning in 1913 the newly-formed Coachella Valley Date Growers' Association sent Johnson back to Algeria for 3 years in succession to purchase a total of 10,000 Deglet Noor offshoots.

Another early private importation from Algeria was made in June 1904 by the California Date Co. This lot of 156 offshoots, mostly of the Deglet Noor variety, was planted in Imperial Valley near Heber, Calif., under the direction of H. F. Chumard. Because of slightly higher humidity and heavier soil, the Deglet Noor variety did not do as well in Imperial Valley as in Coachella Valley. In 1916 the entire lot was purchased by D. B. Holmes and moved to Indio.

The principal commercial importations are listed in Table 1 (17). The American Date Co., which had aequired the planting started by Bernard Johnson, sent H. F. Cole to Algeria in 1911 to make the first large commercial importation of Deglet Noor offshoots, followed by a second one the following year (6). Ineluded in the second importation were 150 offshoots from Morocco, all of which, according to Cole (verbal communication 6 July, 1937), later died because they were shipped without any packing material.

Paul Popenoe, representing the West India Gardens, imported 1000 Deglet Noor offshoots from Algeria in 1912. Accompanied by his brother, Wilson, he went to Iraq in August of that year and after a study of date varieties in the Persian Gulf region imported 9000 offshoots in 1913. To this importation most of the present commercial plantings of varieties from that region are to be traced (21). Then he backtracked to Algeria and from there, with the help of Henry Simon, who had been sent by the West India Gardens to make preliminary arrangements, shipped another 6000 Deglet Noor offshoots to California.

From 1920 to 1922 S. C. Mason, of the U. S. Department of Agriculture, in trips financed by date growers, obtained from Egypt the offshoots that made possible acreage plantings of the Saidy and Hayany varieties.

THE UNITED STATES DEPARTMENT OF AGRICULTURE

After his return from Algeria in 1900 Swingle studied climatic and soil conditions in the desert areas of the Southwest and concluded that the Salton Basin of the Colorado Desert was better adapted to date culture than any other region in the United States (30). The Coachella Valley, a northwestern extension of the Salton Basin, was particularly promising. Artesian water had been found there, it was near the more developed coastal areas and a main line railroad from Los Angeles to New Orleans passed through it. It had already attracted the attention of a few pioneers who were interested in new crops for the region.

In 1904 under Swingle's direction the U. S. Department of Agriculture began an experimental date garden on leased land 2 miles east of Mecca in Coachella Valley. This first station was established in cooperation with the California Agricultural Experiment Station, but from the beginning it was operated by the federal government. For the first 3 years Bernard Johnson, whose property was adjacent, was employed to look after the planting and care of offshoots in the new station. Then in 1907, because of the threatened flooding of the Mecca station by the rising waters of the newly formed Salton Sea, headquarters for experimental work were moved to a new location 2 miles west of Indio. Fred N. Johnson (no relation to Bernard Johnson) donated to the federal government land for this purpose—10 acres first and another 10 a little later. This second station has been the center for date research since its establishment, but some work was carried on at Mecca for about 25 years before it was discontinued.

Offshoots of date varieties imported by the U. S. Department of Agriculture were planted at the Mecca and Indio stations, and their subsequent fruiting afforded an opportunity for evaluation and selection for future planting. Bruce Drummond, superintendent up to 1923, along with S. C. Mason, Swingle's field representative, did pioneer work on cultural problems and fruit handing.

The U. S. Department of Agriculture, primarily through the Indio experiment station, has played an important part in the development of the date industry and through its research has greatly extended our scientific knowledge of the date palm and the conditions necessary for optimum fruit production (18). This is not to minimize the valuable contributions made by the University of Arizona and the University of California, but only to point out that experimental work on dates in Coachella Valley was initiated by the U. S. Dept. of Agriculture and has been carried on continuously at the Indio station. Most of this work since 1924 has been reported at the Annual Date Growers' Institute, which was started by W. T. Swingle in cooperation with county farm advisors M. M. Winslow of Riverside and E. L. Garthwaite of Imperial and T. J. Gridley of the Coachella Valley Farm Center. The annual Reports of the Institute have been invaluable in disseminating information about dates and providing for the discussion of problems affecting the industry.

SEEDLINGS IN COACHELLA VALLEY

Up to about 1915, or until offshoots of imported varieties became available, many date seeds were planted in Coachella Valley. A few of the seedling gardens were profitable for a while. As long as dates were a novelty, they could be sold at a good price in spite of the diversity of fruit, but when a uniform product of superior varieties began to reach the market, seedlings suffered by contrast and lost their appeal to prospective growers and many who had planted them began to change to imported varieties. After they ceased to be profitable, most seedling plantings were neglected and subsequently removed. By selecting and propagating a few of their best palms, some seedling growers were able to keep going. A few will be mentioned either because of their influence in promoting date culture or because they originated new varieties, specimens of which are still found locally.

One of the pioneers who did much to at-

tract attention to the possibilities of commercial date culture in Coachella Valley was Fred N. Johnson, who took up a homestead 2 miles west of Indio in 1900 and, as has been noted, gave 20 acres for the experiment station. He had a few seedling palms and in 1905 obtained 4 Deglet Noor offshoots from the U. S. Department of Agriculture. He gave these 4 palms special care and kept detailed records of his income from them. He is credited with having marketed the first fancy packs of Deglet Noor dates sold commercially in the United States(20). Photos of the palms with a summary of his experiences were published at intervals for several years by the Indio Date Palm beginning with its first issues in 1912. Feature writers who wrote about date culture in Coachella Valley seldom failed to call attention to his experiences. This publicity and the obvious superiority of the Deglet Noor fruit over that of the seedling palms in the same garden did much to encourage the planting of that variety.

One of the most influential boosters of seedling dates was James H. Northrop, who in 1911 planted 20 acres on his property 3 miles west of Indio. A little later he subdivided 80 acres into 5-acre tracts. On some of these he planted selected seedling dates and sold them for $1000 an acre. Northrop built a packing house and was marketing his own fruit in 1916. At the same time he was active in efforts to develop cooperative packing and marketing. He was somewhat of an inventor and devised a date shredder that attracted some attention and was used in 2 or 3 packing houses. Because of his promotion of seedling dates, some feature writers called him the "seedling date king." Among later owners who developed and marketed seedling dates from some of Northrop's tracts were: A. W. Risher (later B. H. Hayes), B. K. Marvin and E. F. Shields (original location).

E. K. Davall planted date seeds on his homestead near Cathedral City about 1911. The original planting became Meyer's Wonder Date Garden, but Davall planted offshoots of his best selections on another tract to the north, where they are still being grown.

Francis Heiny, who homesteaded in Imperial Valley about 1904, was a pioneer date grower in that area. He planted date seeds and originated several new varieties which are still being grown on a small scale. Most of his fruit has been sold through dealers in Coachella Valley and a few of his seedling selections are being grown here.

FRUIT HANDLING

The first date packing house in Coachella Valley appears to have been one built by the American Date Co. (formerly Bernard Johnson planting) in 1912 and operated that year by A. J. Buchatt.

The growth of the California date industry may be followed through the history of group cooperative organizations for the promotion of date culture and the handling and marketing of fruit. The first of these, the Coachella Valley Date Growers' Association, was organized in January 1913, largely by the efforts of W. L. Paul (20), to promote date culture and import offshoots. It was incorporated in March 1917, and began packing dates for its members the next fall in rented quarters at Thermal under the supervision of J. W. Newman. In 1918 W. L. Paul, the first president, was replaced by C. E. Cook, who in the summer of 1919 reported on the operation of the Association for the 2 previous years. Most of the fruit handled was from seedling palms and its diversity and short shelf life presented marketing problems. Deglet Noor fruit brought twice as much per pound.

Although some fruit was handled for another season in the facilities of the Coachella Valley Date Growers' Association at Thermal, several of the leading members abandoned it in 1919 to join other date growers in forming California Date Association. At a meeting on June 9, $50,000 was raised by 60 subscribers to build a packing house near Coachella on what is now Highway 86. Although most of the capital was put up by E. E. Downing, W. L. Paul was one of the most active promoters. The new packing house, known as "Covalda" (Coachella Valley Date), was formally opened in October, but not completed until November. Because of the delay a large part of the 1919 crop was handled in a packing house that had been built by James H. Northrop on his property west of Indio near what is now the intersection of Madison and Highway 111. The operation of the Covalda packing house was a disappointment. The people in charge were inexperienced and a large part of the fruit handled was from seedling palms. After only one year the California Date Association discontinued operation of the packing house. Subsequently the building with facilities was leased for 3 years, then used for storage until 1932, when Leonhardt Swingle and Lee Anderson began operating it as a packing house. Swingle was associated with Anderson for 6 years. Since then Anderson has had the packing house alone continuing under the name of "Covalda".

CALIFORNIA DATE GROWERS' ASSOCIATION

Dissatisfaction with the results of handling seedling dates and miscellaneous varieties in the same packing house led 7 growers in 1919 to form the Deglet Noor Date Growers Association, a cooperative restricted primarily to the principal variety in Coachella Valley. The following year packing operations were begun on a small scale in the former Northrop packing house previously mentioned. T. H. Rosenberger was the first manager, followed by C. E. French. In 1922 a small packing house was built at the corner of Deglet Noor St. and Highway 99 in Indio. C. E. Cook, who was president and general manager after the Association moved into the new building and until his death in 1927, is given a large share of credit for getting the organization off to a good start. In 1932 the name was changed to the California Date Growers' Association. The packing house has been enlarged and remodeled from time to time because of increased volume, the installation of improved machinery or economic changes. The tonnage of fruit has varied with fluctuations in membership and seasonal variation in yield, but in spite of growth never exceeded 50 percent of the Coachella Valley crop up to World War II.

OTHER PACKING HOUSES

After 1919 many growers, such as G. H. Narbonne, W. L. Paul, George M. Beach and others who had sizable plantings of imported varieties of dates and most of whom had been members of one or both of the first two associations, began to handle their own fruit. Existing buildings were adapted for the purpose or a packing house was built of such size as the tonnage might require. Often in the beginning they were family operations with seasonal help from neighbors as required. The smaller grower sometimes arranged to have his fruit handled by the larger grower.

An appreciable tonnage of fruit was packed outside Coachella Valley: that of B. K. Marvin in Riverside; D. B. Holmes in Beaumont; and the American Date Co. in Los Angeles after some years at Mecca.

In 1920 the Valley Packing Association was organized for the purpose of handling miscellaneous imported varieties, mostly the soft varieties from Iraq (25). With Robbins Russel as president and R. H. Postlethwaite as general manager, it began packing in 1921 in the Covalda packing house, but moved to El Monte for the next season, then in 1923 to its own packing house in Monrovia, which was operated until after World War II.

DEPRESSION YEARS

The depression of the 1930's brought hard times to the date industry. Deglet Noor offshoots which up to 1929 sold for $20 each had no buyers at any price. Many were given away for the cutting or destroyed before reaching large size. Fruit production was increasing, but nearby markets that had been the outlet for the bulk of the crop were not expanding. The fruit of individual growers varied greatly in quality and was sold wherever possible. Buyers competed for a cheap product and some of the low grade fruit was reconditioned and sold in competition with better grade fruit.

In 1933-34 an effort was made to coordinate and regulate the marketing of dates by setting up a California Date Exchange patterned after somewhat similar organizations in the citrus industry (26), but it failed for lack of industry-wide support.

In 1933-34 an attempt was made to take low grade dry dates off the market for whole dates by means of a "dry date pool", but it did not succeed because of inadequate financing and lack of a market for date by-products. In 1936 the same idea was followed up in a substandard date diversion program sponsored by the Coachella Valley Date Growers Association, a different organization from the earlier one of the same name. This time an act of Congress passed in 1935 made it possible to get a government subsidy of 3½c a pound for low-grade dates diverted from the whole date market. The subsidy was continued for the crop years 1936 through 1941, inclusive. At first the low-grade dates were sold with the understanding that the buyer would convert the fruit into by-products. This did not work, so the organization took over the responsibility for preparing dates so they could not be used for anything but by-products (22, 23, 27).

In 1937 a cooperative non-profit marketing association of date growers was organized under the name of United Date Growers of California (7, 10). For the first 3 years fruit was sold through a sales agent, but United set up its own sales agency in 1940. During the war period United handled over 70% of the crop, high prices for dates prevailed and all fruit was marketed at a high profit. After the war, prices fell and United Date Growers, which had no control over its constituent packers, was unable to survive.

One factor that has helped to stabilize fruit handling has been regular fruit in-

spection, which was begun in 1938 under a State Marketing Order patterned after the Federal Agricultural Marketing Agreement Act of the previous year. Under this order it became illegal to market substandard dates as whole dates.

PARLATORIA SCALE

A threat to the future of the date industry was eliminated in the early 30's by the parlatoria scale eradication program. **Parlatoria blanchardi** (Targ.) is the only serious scale pest of the date palm. It occurs in date-growing areas of the Old World, but where dates have long been grown it is usually held in check by natural enemies. When offshoots are imported, the predators are left behind and serious damage may result. In spite of the fumigation of all imported offshoots by the federal government, some few scales survived to reappear as the young palms began to grow. A small crew of inspectors was employed by the Federal Horticultural Board beginning in 1914 in hopes of eradicating the scale and many gardens were cleaned up. In 1927 new infestations discovered in Arizona and California indicated that a more intensive effort was necessary. Responding to grower pressure, the federal government and the States of California and Arizona appropriated funds for an all-out eradication program. B. L. Boyden, federal entomologist, was placed in charge. With large crews, systematic inspections and treatment, eradication was believed to have been accomplished by 1934, and the campaign was discontinued after 2 more years. This is one of the few instances on record of the complete eradication of a pest of this kind (5).

THE FREEZE OF 1937

The only very serious damage to date palms from low temperatures since the establishment of the date industry occurred in January 1937. A minimum of 13° F was recorded on January 22 at the Indio experiment station, with low temperatures 3 nights in succession bringing a total of 10 hours below 20° F, a point determined by many observations to be critical for damage to date leaves. All date palms were injured according to variety and location. From 50 to 90 percent of the leaf area was killed. Damage was most severe on the periphery of the crown. The date palms were a sorry spectacle afterward. Palms flowered as usual in the spring of 1937, but most growers left more fruit than the reduced leaf area of the palm could support. As a consequence the fruit in 1937 was small and of poor quality and in 1938 there were few flowers and a reduced crop. It took 3 years for the palms to recover (14, 15).

LOOKING BACKWARD FROM 1971

The distribution of Medjool offshoots by the U. S. Department of Agriculture beginning in 1944 marked the end of the period of variety introduction. I will not carry the history of the date industry any farther in this paper. However, a few observations as one looks backward from 1971 may serve to put the early story in perspective.

Little has been said about Arizona because the date industry there, which reached a peak of about 550 acres in the Salt River Valley in 1947 with several packing houses in operation (3), has passed almost entirely out of the picture. Experimental work on dates at the Tempe Date Garden, which was started with Swingle's importation of 1900, was discontinued in 1941. In the first 2 decades A. E. Vinson did pioneer work on date processing. Other later investigators made important contributions. Some field experiments were carried on until 1955. After the palms came into bearing, the behavior of the many varieties at the Tempe Date Garden was evaluated and published in the annual reports from time to time, but none was outstanding in adaptation. No sizable commercial plantings were made until after the large importations in Coachella Valley.

Unfortunately, the climate of the Salt River Valley is not well adapted to commercial date culture. It has about 3 times the rainfall of Coachella Valley, half of it occurring in summer and causing frequent damage to the fruit. With the rapid increase in population following World War II, the date gardens that were developed in the 20's and 30's and seemed to have promise for a while have been subdivided (9).

The University of Arizona has had an experimental planting of date varieties at Yuma since 1905, but has done little research there, although the climate is better adapted to date culture than in any other part of Arizona. Bernard Johnson's 1912 importation of 3000 Deglet Noor offshoots was planted near Yuma, but that variety did not prove well adapted to the locality. After Johnson's death in 1918 his original planting was operated not as a fruit-producing garden but as a nursery from which young Deglet Noor palms were sold mostly to growers in Coachella Valley. Several commercial plantings were made near Yuma in the 20's and 30's, but after World War II interest in dates began to subside and there are now only a few small date gardens, hardly commercial operations by Coachella Valley standards.

Because of interest in the possibility of establishing date culture in South Texas, the Texas Agricultural Experiment Station began an experimental program with dates at the Weslaco station in 1926 in cooperation with the U.S. Dept. of Agriculture. Offshoots of different varieties were sent from Indio and a Congressional appropriation in 1928 made possible an importation of offshoots from Iraq the following year. In 1932 a second date variety planting was started at the Winter Haven substation between Laredo and San Antonio. By World War II it was evident that there was no future for commercial date culture in Texas and the experimental program was abandoned. The rainfall beginning in late summer is about twice that of Salt River Valley. However, many people grow a few date palms for home use.

Date acreage in California reached a peak in 1951 and by 1969 had decreased over 500 acres, as shown in Table 2 (4, 28).

Table 2. Date acreage in California.

	Coachella Valley	Elsewhere	Total
1951	4887	273	5160
1969	4380	230	4610
Difference	-507	-43	-550

In spite of the fact that nearly all the older plantings in Imperial Valley and the isolated ones in Death Valley and Borrego Valley have gone out of production, there were still 230 acres outside Coachella Valley in 1969. This is explained by the planting during the last few years of a considerable acreage of the Medjool variety in the Bard district on the California side of the Colorado River about 8 miles above Yuma. The palm census recently completed by the agricultural commissioner of Imperial County, which includes the 1970 plantings, reports 250 acres of Medjools in the Bard district. This is the only commercial development of any consequence outside Coachella Valley.

It is apparent that Coachella Valley has almost a monopoly of date production in the United States. Changing economic conditions during the past several years have created uncertainty and misgivings about the future. This is a critical period. Predictions are hazardous. However, the skill and knowledge acquired through more than half a century of experience and research justify optimism if the determination and creative effort applied to the problems of the past are applied to those of the future with emphasis on quality, handling and marketing.

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SUMMARY OF FRUIT QUALITY PROBLEMS

R. M. PERKINS and E. G. VIS[1]

On 27 January 1971 a meeting was held to discuss the dry fruit problem in the date industry. Represented were all organized research groups now working in dates, plus growers and packers. The first thing that became apparent out of the discussion was that the problem was not a new one, but one which has been getting somewhat worse each year. It also has been increased by the advent of mechanical harvesting which has required some delay in harvesting. In addition, the processing and marketing have become more difficult with the removal of Fumold (15% ethylene oxide and 85% methyl formate) as a preservative.

A DISCUSSION OF THE DRY FRUIT PROBLEM

There are two types of dry fruit: 1) a fruit that has gone through a "natural stage" on the palm and because of delays in harvesting has dried down to a lesser quality date; 2) a fruit which because of some undefined climatic and cultural condition has never matured to a natural or waxy fruit, but instead has gone from the khalal stage to a dry date. This means that the proper conversion of sugars and the enzyme breakdown of cell walls have not occurred and the date has remained tough and dry even after processing. While type 2 will never make a good quality date regardless of processing, type 1 with proper processing can be made into an acceptable marketable date and would be preferred for carry-over fruit which will remain in storage for extended periods.

Large differences in fruit quality exist between fruit grown in different parts of the valley. Fruit in the southern end of the valley matures earlier than in the western end, averages a much lower percentage of marketable fruit (45%-50%), and is usually dryer. The western end (Palm Desert) produces a much higher percentage of marketable fruit (70-80%), and the fruit in general is much higher in moisture.

Because a large portion (70%) of the crop is carried over each year in storage, the packing houses face a difficult problem. The early fruit, which could be marketed directly without storage, is the dry fruit, which is difficult to process; whereas the moister fruit from the Palm Desert area, which could be packed with little processing, does not mature until December or later and therefore must be stored until the next fall. This is the most difficult fruit to store because of its high moisture content.

Considerable discussion of the reasons for these differences in maturity of dates and quality occurred, but no definite conclusions could be reached. Some of the theories were:

Higher temperatures occur in the southern area of the Valley, particularly during spring and fall, which may be critical periods in the development cycle of the date. It was brought out that Algeria, the native home of the Deglet Noor variety, is about 8° F cooler in the spring and fall than Indio. Temperature records taken in the spring during pollination indicate that the southern area of the Valley may be as much as 5° F warmer than the Palm Desert area. This higher temperature may produce stress in the plant during these periods.

Hot, dry winds may also influence the development of dry fruit.

Another point brought out was difference in water quality between the two areas. The southern area of the Valley uses canal water almost entirely, which is much higher in salts than the well water used in the Palm Desert area.

It was also pointed out that within a given garden, or between adjacent gardens, a large difference in quality can exist. Reasons for these differences are presently unexplained.

FIELD CONDITIONS RELATED TO DRY FRUIT

Since there are so many climatic differences between the western and southern ends of the Valley, it was decided the most practical place to begin any field research on climatic differences as they might influence fruit quality should be between areas in the same garden or adjacent gardens which show differences in quality. For this purpose we have chosen locations in 3 gardens in the southern end of the Valley in which we will measure soil and air temperatures, water stress in the soil and palm, and fruit quality to determine whether there are any differences.

Observations of aerial pollination blocks in 1966-67 and ground-level pollination blocks in 1968-70 indicated that the retention of unpollinated fruit on the bunch would keep the stalk and strands alive, thereby reducing the amount of drying occurring in this fruit. Fruit size and fruit quality were both improved considerably. It was suggested that investigation be made of the possibility of maintaining a given amount of unpollinated fruit on the bunch to help increase fruit size and quality without sacrificing yields.

At present what method or materials might be used to stop fertilization of the flowers but yet retain the unpollinated fruit is unknown.

Certain growth regulators might also tend to delay the drying of the bunch and fruit during the maturation process. At present no one familiar with growth regulators is available to work on the problem.

PACKING HOUSE PROBLEMS RELATED TO DRY FRUIT

As previously stated, the problem of processing dry fruit has been greatly increased by the Food and Drug Administration's removal of ethylene oxide as a preservative in 1970. Before then dry fruit could be hydrated to a higher moisture content to enhance quality and pitting ability. Because spoilage organisms are less active below 22½% moisture content, it has been necessary to process the fruit in a dryer condition in order to reduce spoilage. Most of the preservatives tried either do not work on dates or cause off-flavors. The Western Utilization Laboratory at Albany has been working on this problem for some time and will continue this research. No results should be expected in the near future because FDA clearance for chemical treatments may take several years in itself.

The Albany Laboratory has also worked to improve grading procedures which would help to classify fruit into groups of more similar characteristics to improve the processing procedures. Some of the methods tried involve sizing, bouncing, light reflectance, and surface roughness. Each of these shows some promise of separating fruit of different character under given conditions but has not always worked on all types of fruit. In addition, none have been presently reduced to a commercial scale or operation. It may be possible to improve the grading procedure by placing different mechanical sorting methods in the proper series in the grading line.

Personnel from the Pasadena Laboratory of the Western Utilization Laboratory have been working on improved methods of hydration to help soften the hard, dry fruit. It has been shown that there is a decrease in enzyme activity in dry fruit. This reduction in activity results in less breakdown in cell wall structure and causes a toughness in the fruit. Addition of different enzymes to the fruit, primarily cellulase, was effective in reducing toughness and improving quality. A vacuum hydration process has been shown most effective for introduction of these enzymes into the fruit. But again reduction of this method to a practical commercial system is some time off.

In summary, there are two types of dry fruit, one caused by delays in harvesting and the other created by some problems in nature. Pre-harvest field work will be done to determine whether any field conditions exist which can be changed to improve the quality of this fruit.

Post-harvest work in the areas of improved grading and processing and acceptable preservatives will continue. This work may take a number of years.

Rather than a solution, at present, all that can be done is to learn to live with the problem and hope that research will find an answer.

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EXPANDED MARKETS FOR PRODUCT DATES

HILLMAN YOWELL[1]

New products are being presented to supermarkets at the rate of 100 items per week, or 5000 per year. This is almost equal to the total number of different items on the shelves of most supermarkets. This means that the manufacturer has to stay on his toes and see that he is upgrading his product, either modernizing or developing something altogether new, to avoid being outshone, out-manufactured or out-positioned.

The following items, all of which contain dates, were displayed at the 48th Date Growers' Institute: Betty Crocker Date Bar Mix, Pillsbury Date Bread, Jiffy's Honey Date Muffin Mix, Chiquita Banana Cake Mix, Quaker Instant Oatmeal with Dates, and Betty Crocker Date Nut Muffin Mix (Fig. 1). In dramatic contrast were packages wrapped in plain white paper, "ghosts" of products that contained Cal-Date products but are no longer manufactured. Though once in national distribution, they lost out to others more interesting or more acceptable to the consumer. Among the ghosts were Pillsbury Date Cake Mix; Hines Date Nut Cake Mix; Quaker Aunt Jemima Date Bread; Pepperidge Farms Fresh Batter (Date Nut Cake), which could not compete with the Sara Lee package; and Betty Crocker Date Muffin Mix, which was replaced by that company's Date Nut Muffin Mix.

This more appealing replacement kept us from losing the Betty Crocker market. Such changes illustrate our need for continual detection of consumers' changing eating habits. Right now we are finding interest in "natural" foods. We have done a lot of work on this and picked up business in our natural date sugar. Sales of all our date products in health food stores have been increasing in the last two months. One reason for their growing popularity is their convenience.

We are also studying the institutional market. We find that many manufacturers are developing institutional convenience items prepared and packaged for use like cake mixes. Pillsbury Date Nut Bread and Chiquita Nut Cake are being packed in institutional size. This field is running at a pretty high level now with delicious convenience items that we have to compete against. With the help of a master baking consultant, we have added ingredients to our finely ground dates (date sugar) to make an instant date filling which can be marketed to institutional users. It requires only the addition of warm water and may have sufficient appeal to absorb half of our supply of dates.

We are finding in date product sales that we must overcome a major misconception in the minds of many people — that dates supply calories but no nutrition. This is, of course, not true. Dates have high nutritional value: for instance, more iron than raisins and more potassium than bananas. It is the only fruit we know of that can be used in diets of persons with circulatory problems. The publicity people have to remove the high calorie stigma and move dates into the category of highly nutritional food — with no preservatives. This is to us the big job, and we have retained a home economist who is working on it with us.

I have been eating dates for the last 35 years and still weigh the same as when I began. For lunch I had a handful of dates, a glass of buttermilk, and an orange and I feel great. Here is the word: dates are a naturally nutritious food. Pass it along.

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Fig. 1. Packages of date mixes now on the market and the date products entering into their composition.

INDUSTRY STABILITY VIA MARKETING

C. HARRY BLEICH[1]

The California date industry is blessed with two basic protections: first, a rare climate, unmatched in the United States, offers an exclusivity in the cultivation of Deglet Noor dates to the Coachella Valley; second, our Deglet Noor variety, which comprises over 90% of our production, can only be propagated from existing trees.

On the other hand, we have been handicapped by lack of funds to capitalize the investment necessary to make our industry a growth industry in both size and profitability. Just as the strength of a chain is limited by its weakest link, the marketing of our dates by handlers, of which we are the largest, has failed to provide the revenues that must support the industry and provide the monies for growth.

I am of the opinion that the problem lies in the traditional method of "selling" dates as compared with the modern business of "marketing dates." Let me distinguish for you the difference between selling and marketing.

Selling is only one component of marketing. Marketing starts with the consumer and develops a sophisticated plan that commences with advance planning and takes the product through ingredient formulation to be sure it specifically represents what the consumer wants to buy, it develops packaging with engineered convenience features, it develops the package design, it coordinates production scheduling, it has responsibility for traffic and distribution, it determines optimum pricing, it creates merchandising support with well-conceived point-of-purchase material and trade programs to accomplish in-store displays that inspire impulse purchases. In brief, marketing identifies a consumer need or desire and plans all of the steps from raw product to the retail package through the various steps of production, sale, and distribution to satisfy that consumer need or desire at a price that the consumer is willing to pay and that will afford a fair return to the producer. We in the date industry are some way from attaining such a marketing achievement. Let me review the evolution that distinguishes selling from marketing.

Many agricultural products are still sold off the pile. When the pile is large the price is low, and conversely when the pile is small the price is high. Unfortunately, this method of selling is most speculative and the least compensatory of all methods of selling a crop.

In many large metropolitan areas the auction technique has been developed for perishable products. Under this method of selling, prices fluctuate with each order and vary with the relative strength of buyer and seller. As dates are considered produce items, they are cast in the perishable category of products.

Differential selling has evolved in which the industry leader sets the price and others in the industry sell at varying prices under the leader. Under this system, unless the industry leader has a commanding share of total supply, it is virtually impossible to accomplish a compensatory return for the growers.

In scientific marketing lies the hope for the grower. It employs the known marketing tools with the precision of an integrated production line. What are these tools?

First, research to determine the size and scope of the market. In the case of dates this would involve an estimate of marketing requirements, followed by a determination of the number of acres to pollinate to meet annual requirements, and the number of offshoots to plant to provide for future requirements.

Research must determine the demographic and ethnic characteristics of the market: age, sex, religion, race and income. Fifty percent of the population in the United States are under 25 years of age. They are the post-World War II generation and they are not familiar with dates. Research must turn to use and attitude studies to predetermine the consumers' attitude toward a product or package, the use they make of it, the things they like or don't like about it, and what feature they would like to have and would buy if it were incorporated in the product. This would involve such items as organically grown dates or convenience packaging for examples.

Research must uncover new products that fill a new need or satisfy a new desire.

Advertising is a key tool of the marketing concept. Advertising is a science today in which every dollar must be rifled instead of shotgunned toward a particular segment of the market to accomplish a specific consumer awareness of the product features advertised. Advertising must identify one brand's superiority over another or make known the unique qualities of a particular brand or product. Advertising is basic to the establishment of a brand that promises and delivers the quality of product the consumer wants to buy and for which she is willing to pay a fair price.

Well-conceived trade programs are an essential step in the marketing sequence, trade programs that are pretested with key trade outlets such as chain stores, independent supermarkets; mass feeders such as restaurants, hotels and institutions; and specialty stores such as health food stores.

Display techniques and point-of-purchase promotional materials must be provided to influence impulse purchases and to keep our products prominently displayed in high traffic areas, not buried with other dried fruits in some remote corner of the store.

Gentlemen, each of our handlers is knowledgeable in these marketing techniques and I am confident that each would like to have the resources to move immediately into a completely integrated marketing program. The economics of our industry have not provided such funds. Therefore, we must develop such a program step by step on an affordable basis by each individual handler over a period of time with a wise investment of available funds pointed toward our ultimate objective, "a compensatory payment to our growers and a fair profit to the handler".

Cal-Date will launch a program later this year that will be a major step towards such an objective. We will introduce the Sun Giant Brand of dates as our top quality line. The Sun Giant brand will also identify the top quality line of all produce, including almonds, marketed by Heggblade-Marguleas-Tenneco Inc., our parent company. This program will be supported by every modern marketing technique. It is a major breakthrough in the establishment of a brand franchise on a comprehensive line of perishable and semiperishable products. Already Sun Giant Asparagus, from the Coachella Valley, has been sold in England and Germany.

Gentlemen, our real success lies in expanding the market for California dates, not in pirating business from each other within the confines of our present industry volume. Skilled marketing offers the means to that end.

I would like to close my remarks on a note of confidence in the California date industry. At this time we find ourselves in the best environment we have experienced since World War II. Marketable dates are in short supply. Our handlers are either sold out or have a specific commitment for their available supplies. At Cal-Date we are 3,000,000 pounds short of our requirement of marketable dates to carry us to new crop. We have a rare opportunity to accomplish industry corrections that have long been recognized as needed. If we are to provide a compensatory payment to our growers, it must be through the accomplishment of a pricing structure in the market place that provides a margin to our handlers that will enable them to make such payments to our growers. I am of the opinion that all date handlers in our Valley subscribe to orderly marketing, and, assuming that is true, I will state with confidence our California date industry has entered a new era.

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